Technical Report EL-93-19
September 1993

US Army Corps of Engineers
Waterways Experiment Station

AD-A273 172

Containment Area Aquaculture Program

Economics and Marketing of Aquaculture in Dredged Material Containment Areas

by C-K Associates, Inc.

Approved For Public Release; Distribution Is Unlimited

93 11 23 061

93-28760

122pp

Prepared for Headquarters, U.S. Army Corps of Engineers

Containment Area Aquaculture Program

Technical Report EL-93-19
September 1993

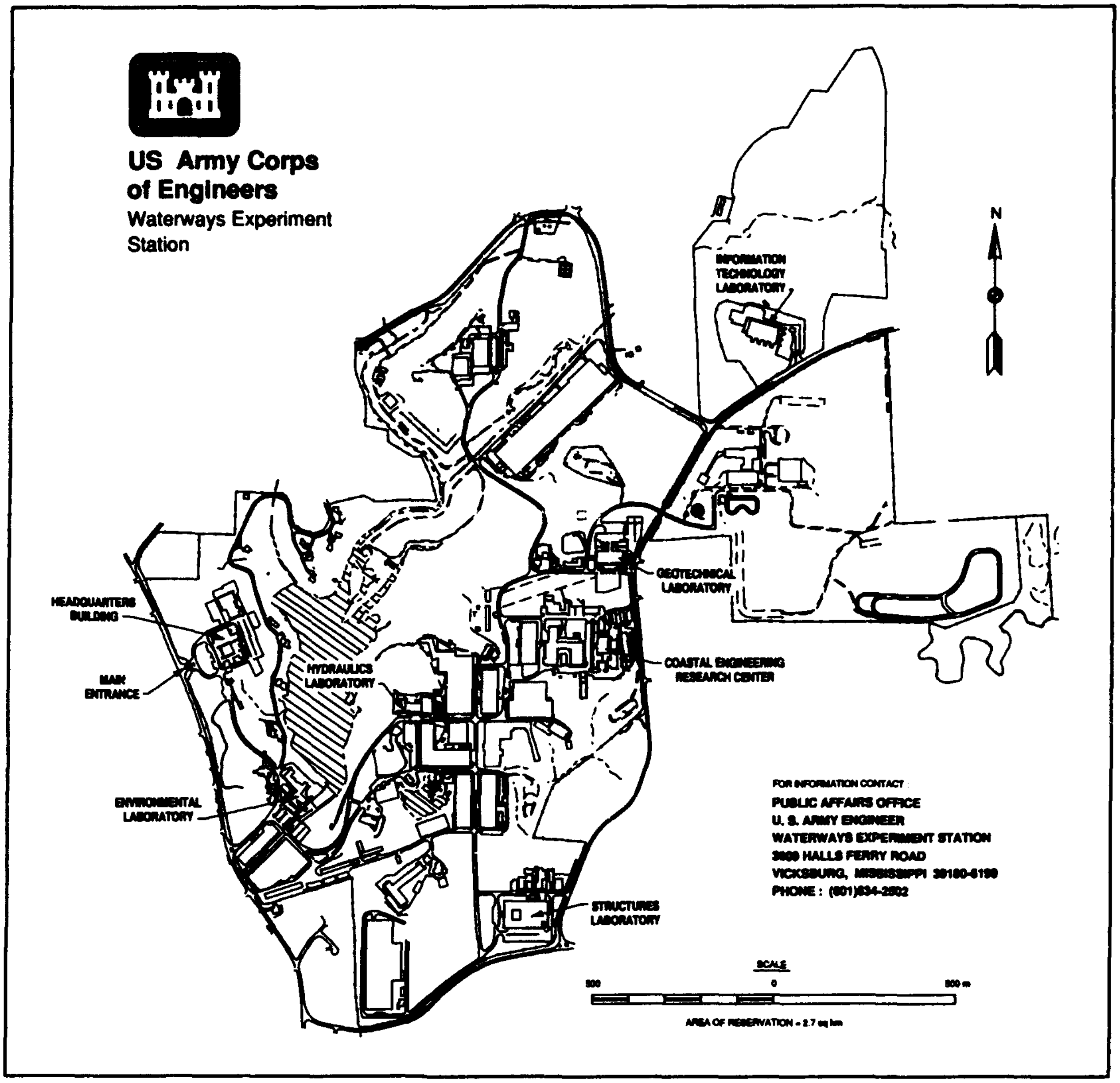
Economics and Marketing of Aquaculture in Dredged Material Containment Areas

by C-K Associates, Inc.
17170 Perkins Road
Baton Rouge, LA 70810

Final report

Prepared for U.S. Army Corps of Engineers
Washington, DC 20314-1000

Monitored by Environmental Laboratory
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, MS 39180-6199



Waterways Experiment Station Cataloging-in-Publication Data

C-K Associates. Inc.
Economics and marketing of aquaculture in dredged material containment areas / by C-K Associates, Inc. ; prepared for U.S. Army Corps of Engineers ; and U.S. Army Engineer Waterways Experiment Station.
120 p. : ill. ; 28 cm. — (Technical report ; EL-93-19)
Includes bibliographical references.
1. Aquaculture — Economic aspects. 2. Fish-culture. 3. Dredging spoil — Economic aspects. 4. Dredging — Economic aspects. I. C-K Associates, Inc. II. United States. Army. Corps of Engineers. III. U.S. Army Engineer Waterways Experiment Station. IV. Containment Area Aquaculture Program. V. Series: Technical report (U.S. Army Engineer Waterways Experiment Station) ; EL-93-19.
TA7 W34 no.EL-93-19

Contents

List of Tables

Preface

This report describes research performed under Contract No. DACW39-89-C-0020, dated 17 February 1989, between the U.S. Army Engineer Waterways Experiment Station (WES) and C-K Associates, Inc., Baton Rouge, LA. The work was conducted under the Containment Area Aquaculture Program (CAAP), sponsored by Headquarters, U.S. Army Corps of Engineers (HQUSACE), and monitored by WES. The purposes of the research were to analyze the economics of the CAAP demonstration project shrimp farm and to use the information learned from the demonstration to examine the economic feasibility of aquaculture in dredged material containment areas (DMCA).

The principal investigators and authors of this report were David G. Marschall and Leona Burrell, C-K Associates, Inc., and Kenneth J. Roberts, a marine resource economist with Louisiana State University, Baton Rouge, LA.

The authors are particularly grateful for the guidance and assistance of Mr. Richard Coleman, Environmental Laboratory (EL), WES, and members of the CAAP Field Review Committee, including Dr. Mark Konikoff, University of Southwestern Louisiana, Dr. Jurij Homziak, U.S. State Department and formerly EL, WES, Dr. Henry Tatem, EL, WES, and Messrs. Herbie Maurer and Rick Medina, U.S. Army Engineer District (USAED), Galveston. Special thanks go to Mr. Durwood Dugger, Cultured Seafood Group, Laguna Vista, TX, who was the onsite manager of the demonstration project shrimp farm. This project benefitted also from the critical oversight of Mr. Jesse Pfeiffer, Jr., Directorate of Research and Development, HQUSACE. The authors also wish to thank Ms. Nancy Hadley and Dr. John Manzi, South Carolina Marine Resources Center; Mr. Braxton Kyzer, U.S. Army Engineer District, Charleston; Messrs. Glenn Earhart, Bob Blama, and Monty Franklin, U.S. Army Engineer District, Baltimore; and Mr. Ron Vann, U.S. Army Engineer District, Norfolk, for their contributions.

Contract Managers for this study were Mr. Coleman, CAAP Project Manager, and Dr. Homziak, former CAAP Project Manager. The study was conducted under the direct supervision of Mr. E. J. Pullen, Chief, Coastal Ecology Branch, WES, and under the general supervision of Dr. Conrad J. Kirby, Chief, Ecological Research Division, and Dr. John Harrison, Chief, EL.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

This report should be cited as follows:

> C-K Associates, Inc. (1993). "Economics and marketing of aquaculture in dredged material containment areas," Technical Report EL-93-19, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

1 Introduction

The Environmental Laboratory (EL), U.S. Army Engineer Waterways Experiment Station (WES), conducted the Dredged Material Research Program (DMRP) from 1973 through 1978. One of the specific goals of the DMRP was to "develop and test concepts for using disposal sites for productive purposes and consider the use of dredged material as a natural resource" (Saucier et al. 1978). Two work units funded under the DMRP that addressed productive uses were: The Investigation of Mariculture as an Alternative Use of Dredged Material Containment Areas (DMCA), and The Demonstration of Marine Shrimp Culture in an Active Dredged Material Containment Area. Important results of these two work units included:

a. Plant and animal species (400) were identified as potential culture organisms in DMCA's.

b. Small-scale studies with shrimp grown in dredged sediments showed no biological limitations to mariculture.

c. Shrimp raised in a 20-acre containment area cell without supplemental feedings grew at a rate comparable to wild shrimp (Saucier et al. 1978; Quick et al. 1978).

Over the last decade, environmental impacts have been given greater consideration in U.S. Army Corps of Engineers (USACE) activities. One result of this has been a shift away from open-water disposal of dredged sediments toward more frequent use of disposal in confined upland sites. However, there has also been increasing difficulty at the district level in obtaining suitable upland disposal sites. Landowners have been reluctant to allow use of their property for sediment disposal without some benefits in return.

These factors, and the positive conclusions reached during the DMRP, contributed to a sustained interest in aquaculture within the USACE. The Containment Area Aquaculture Program (CAAP) was thus initiated in 1986, as a development of the Environmental Effects of Dredging Program, to fully examine the beneficial-use concept of aquaculture with emphasis on more economical and environmentally compatible site acquisition. The CAAP had two major activities: a field demonstration of aquaculture in a DMCA on a

commercial scale, and the exchange of information on DMCA aquaculture to districts, local sponsors, and the interested public.

Maintenance dredging in waterways often requires long-range planning to ensure the availability of sites to deposit dredged material. The CAAP is expected to reduce the difficulty of obtaining deposition sites by offering landowners an inducement to cooperate with local USACE districts. This inducement can take the form of revenues to the landowner who leases his land for aquaculture, as well as savings to the aquaculturist in the costs related to pond construction. In addition, landowners and aquaculturists will receive technical aquaculture assistance through information transfer from the CAAP demonstration project in Brownsville, TX.

Containment area aquaculture can have positive impacts other than those which directly affect the landowner and the district. An aquaculture operation will provide employment for the local workforce, will stimulate the local economy, and may improve wildlife habitat by the creation of protected waterbodies. The program also represents resourceful land use and will foster a mutually beneficial partnership between USACE and the private sector.

This report provides analyses of the economics and marketing of the field demonstration project. The analyses identify and quantify the various costs of a DMCA aquaculture venture that would be incurred by the USACE district and the aquaculturist. Of particular interest are the savings to the landowner or aquaculturist who cooperates with the USACE. A PC-based model is also presented which allows determination of the economic feasibility of rearing different species in containment areas of different sizes. Data from aquaculture literature are used to "test" the feasibility of rearing catfish, crawfish, hybrid striped bass, and mollusks in DMCA's. Results of these feasibility tests are provided. Finally, the data sources used in preparation of this report are arranged with other sources of aquaculture data to provide a useful reference section for those interested in pursuing information further.

More detailed information on DMCA aquaculture is now available or will be available in technical reports from the CAAP. These are listed in Chapter 6 of this report. Topics addressed include: legal and institutional constraints; chemical suitability; site selection, acquisition, and planning; design and construction; and pond operations.

2 The CAAP Demonstration Project

Background and Purposes

After nearly a decade of deliberation concerning the potential use of DMCA's for aquaculture, a large commercial-scale demonstration project was established between Brownsville and Port Isabel, TX, late in 1986. The site encompassed approximately 230 acres on the eastern side of the Brownsville Ship Channel. The demonstration project had multiple purposes as cited by Homziak, Coleman, and Dugger.[1] The purposes included:

a. Determination of design specifications and construction methods that would allow multiple use of DMCA's for both aquaculture and dredged material disposal.

b. Development of management strategies that would allow aquaculture operations and material disposal to coexist.

c. Documentation of construction and production costs that would allow an objective evaluation of economic success to be made.

d. Compilation of the economic and technical information generated by the demonstration.

For shrimp farm management, the USACE contracted initially with MariQuest, Inc., a California-based, full-service mariculture consulting and development company. The work of Mariquest was completed in 1989 by Cultured Seafood Group, Inc., Laguna Vista, TX. The project was in operation from 1986 to the fall of 1989.

The project was under the overall supervision of the WES CAAP managers with onsite coordination and construction supervision of the U.S. Army Engineer District (USAED), Galveston, through the Brownsville Area Office. The

[1] J. Homziak, R. Coleman, and D. Dugger. (1987). "Development and operations of the Containment Area Aquaculture Program (CAAP) demonstration shrimp farm" (unpublished).

Brownsville Navigation District, an independent political entity of the State of Texas, was the landowner and dredging sponsor.

Construction and Production

In 1986 and 1987, modifications for aquaculture were made to two large containment areas: Disposal Area (DA) A, 104 acres, and DA B, 116 acres. (These acreage figures have been adopted for consistency in calculations. Many aquaculture cost and production values are expressed as "dollars per acre" or "pounds per acre.")

A 4-acre nursery pond was built adjacent to the two larger ponds and to the water intake structures. Changes made to the existing DMCA's included raising the perimeter levees to 12-ft elevation (el)[1] above the pond bottom, widening the levee crown widths to between 12 and 15 ft, contouring the pond bottoms to facilitate drainage, and installing an in-levee water control/harvest structure.

Two crops of the white shrimp *Penaeus vannamei* were raised in 1987. After stocking and rearing postlarvae in the nursery pond, shrimp of both crops were moved to Pond A for growout. The first crop was harvested in September 1987 and produced 106,037 lb of whole shrimp with 75-percent survival. The second crop was harvested in December 1987 and produced 48,425 lb with 56-percent survival. The two 1987 crops received semi-intensive management, the most important aspect of which was daily feed rates of between 1.5 and 3 percent of whole shrimp body weight. The total Pond A yield of 154,062 lb represented a respectable 1,481 lb per acre for 1987.

In 1988, three growouts were attempted to demonstrate alternative production scenarios. Pond B was stocked at a similar rate as the 1987 crops and also received semi-intensive management after having received dredged material the previous summer. Production of a mix of *P. vannamei* and *P. stylirostris* totaled 70,459 lb or 607 lb per acre. Pond A was stocked with the same two species, but shrimp were not fed (extensive management). Growth of the shrimp appeared to be satisfactory, but survival was limited to only 3.4 percent due to predation by sea trout which had entered as postlarvae due to a failure of the predator filter in the intake structure. The third alternative was the stocking of a cool-tolerant species *P. penicillatus* during the winter of 1988-89. These shrimp were killed by unusually cold temperatures during February 1989.

One crop was attempted in 1989. This was also a mix of *P. vannamei* and *P. stylirostris*, but a worldwide shortage of postlarvae prevented finding

[1] All elevations (el) cited herein are in feet referred to the National Geodetic Vertical Datum (NGVD) of 1929.

sufficient good quality seed stock which and resulted in poor survival and growth. Final production was 31,206 lb of small shrimp, or approximately 300 lb per acre.

Table 1 summarizes the production record for the six crops of the CAAP demonstration project.

Once harvested, shrimp were transported to a processor where they were graded, deheaded, packed, and frozen. Smaller shrimp were sold in the peeled, undeveined (PUD) product form. Shrimp were then kept in cold storage where they were sold from inventory at the discretion of MariQuest and based upon prevailing shrimp market prices. Revenue from shrimp sales was returned to the U.S. Treasury.

An important aspect of the demonstration project was the opportunity to determine the costs of pond construction and installation of a water control/harvest structure. These important start-up costs were later examined from the viewpoint of the aquaculturist as well as from the viewpoint of the USACE district.

Galveston District Costs

The USAED, Galveston, Operations Division manages maintenance dredging in the Brownsville Ship Channel. District personnel calculated the costs to the district of converting the two existing DMCA's, DA 4A and DA 4B, to aquaculture ponds.

DA 4A became the 104-acre Pond A. It was converted between 5 March and 8 May 1986. Work required moving 56,800 cu yd of material to construct 9,566 lin ft of perimeter levee. In addition, 2,000 ft of ditch to facilitate draining required moving 15,700 cu yd of material. Material moving costs and the installation of an in-levee water control/harvest structure amounted to $203,149. An additional $40,000 in costs were attributed to engineering, design, inspection, and administration. If the district not been meeting the needs of a shrimp farmer, these costs would probably have been $85,000 and $15,000, respectively.

DA 4B became the 116-acre Pond B. Conversion took place between 27 March and 8 June 1987 and required moving 82,358 cu yd costs of material to construct 12,000 lin ft of levee. District costs for construction were $90,055, and costs for engineering, design, inspection, and administration were $18,000. Estimates of these costs without the shrimp farm were $82,000 and $16,000, respectively. Table 2 summarizes the costs to the Galveston District with and without the demonstration project.

The levee construction costs for DA 4B were considerably less than for DA 4A on a cubic-yard basis because the DA 4B costs were part of a larger

Table 1
CAAP Demonstration Project Stocking and Production Record

	1987		1988			1989
	CROP 1	CROP 2	CROP 3	CROP 4	CROP 5	CROP 6
	POND A	POND A	POND A	POND B	NURSERY & POND B	POND A
Species	*P. vannamei*	*P. vannamei*	*P. vannamei* *P. stylirostris*	*P. vannamei* *P. stylirostris*	*P. penniciliatus*	*P. vannamei* *P. stylirostris*
Stocking Month	March	July	April	March, April	Sept., Nov.	May, June, July
Harvest Month	September	December	November	November	February	October
Time in Pond - Weeks	24	22	28	31	16-24	15-21
Days Above 24 Degrees Celsius	132	106	170	130	N.A.	111
Days Above 36 PPT Salinity	103	67	142	122	N.A.	109
Stocking Rate - Postlarvae/Acre	40,000	40,000	22,000	42,000	N.A.	47,600
Survival	74%	56%	3.4%	50.6%	0%	23%
Management	Semi-intensive	Semi-intensive	Extensive	Semi-intensive	Semi-intensive	Semi-intensive
Feeding - % Body Wt/Day	1 1/2 - 3	1 1/2 - 3	None	1 1/2 - 3	5	1 1/2 - 3
Feed Conversion Ratio	1.5:1	0.68:1	N.A.	1.77:1	Unknown	2.45:1
Yield - Whole Shrimp, Lb	106,037	48,425	4,504	70,460	0	31,206
Yield - Whole Shrimp, Lb/Acre	1,020	466	43	607	0	286
Yield - Tails Only, Lb	66,175	29,055	2,785	44,390	0	18,724
Yield - Tails Only, Lb/Acre	636	279[1]	27	383	0	180
Majority Size	36-50 Tails	51-80 Tails	16-35 Whole	41-70 Whole	0	51-80 Tails

[1] peeled and undeveined weight

Table 2
Summary of Galveston District Costs With and Without CAAP Demonstration Project

Cost Category	Costs Incurred With Demonstration Project		Estimated Costs Without Demonstration Project	
	DA4A	DA4B	DA4A	DA4B
Engineering, Design, Administration	$40,000	$18,000	$15,000	$16,000
Construction	$203,149	$90,055	$85,000	$82,000
Pond Cost Totals	$243,149	$108,055	$100,000	$98,000
Project Cost Totals	$351,204		$198,000	

dredging contract. They represented approximately one-fourth of the total amount of levee work required under a $1.2 million contract. Levee costs for DA 4A were contracted separately.

Other costs for completion of the demonstration site were incurred by the shrimp farm operators. These included expenditures for caliche (a form of road aggregate used in south Texas) and for grading levee crowns to make them suitable for vehicular traffic. Such costs will be necessary at most any site and probably will be the subject of negotiation between the USACE district and the aquaculturist or landowner. The USACE district may bear all or part of costs such as these if the items are required for or contribute to material disposal.

At the demonstration project site, caliche and levee grading costs were borne by the operators because they were necessary for aquaculture and not for operation of the containment areas.

3 Evaluation of the Demonstration Project

Methodology

The CAAP demonstration project was a simulated commercial venture which allowed the USACE to examine the commercial feasibility of DMCA aquaculture. It was subjected to the scrutiny that would be given similar aquaculture operations. Besides the standard profit-and-loss determinations, the financial analyses were to quantify specifically those costs that would represent a savings to the aquaculturist.

Software program

The WES project managers were provided monthly accounting sheets from the shrimp farm management contractor, MariQuest, Inc. This monthly identification of costs was sent to the USACE for documentation prior to payment to MariQuest, Inc. These data were utilized in a software package called AQUADEC, which is a compilation of budgeting and financial decision support tools for the new or ongoing commercial freshwater or marine aquaculture businesses. AQUADEC was developed at the University of Florida by Dr. Charles Adams of the Food and Resource Economics Department and can be purchased through the Florida Sea Grant Program. This software package allows the business manager to develop a wide variety of financial statements and supportive information to aid in the decision-making process. Financial statements which can be generated using AQUADEC include cost recovery schedules, loan amortization schedules, income statements, monthly cash flow statements, balance sheets, operating budgets, and others. The user can also perform breakeven analyses on price and production and can assess the financial performance of the business through the use of a set of financial ratios. With these tools, the user can describe a 5-year planning horizon and a specific operational year, vary key parameters (such as price received for a unit of production), and ask "what if" questions of an economic financial nature. Individual aquaculture business managers can use AQUADEC to analyze production, financial and management scenarios, and evaluate the impact that certain changes could have on profitability.

Sources of input data

The data used in the anlyses of the demonstration project came from four sources. The primary source was the monthly accounting records submitted by MariQuest. When the data in these records were not suited to the format of AQUADEC, MariQuest's monthly narrative reports were relied on to clarify cost totals or categories. The monthly narrative reports were thorough summaries of all activities that took place at the shrimp farm including (among others) all personnel matters, purchases, stocking, harvesting, and sales. The third source of data was the WES Property List which identified all buildings, machinery, and equipment. The list was a detailed inventory of 180 items and the acquisition cost of each. The final data source was a listing of costs prepared by the Operations Division of the Galveston District. This list identified those costs described in Chapter 2 of this report that were incurred by the district when the shrimp farm was constructed initially.

Fitting the data to the program

It was recognized by the CAAP managers that there would be potential advantages and disadvantages to having a third party analyze the economics and marketing of the demonstration project. A positive aspect was the opportunity to have the shrimp farm analyzed as a pure business and not as a demonstration. There was corresponding difficulty, however, in analyzing records as much as 3 years after they had been submitted to WES by MariQuest. Though MariQuest kept thorough accounts, the use of AQUADEC, a standard business analysis program, meant that shrimp farm data had to be "fitted" after the fact to a format that was perhaps not flexible or sensitive to the nature of the demonstration project. Certain assumptions were made and problems were encountered that warrant further explanation.

Seven categories of costs ranging from accounting to management expenses were recorded separately by MariQuest. These were lumped as general and administrative (G&A) in AQUADEC. Operating expenses were placed into 10 categories: feed, fuel, labor, fringe benefits, leases, rent, repair and maintenance, seed stock general supplies, and other (postage, printing, telephone, travel, etc.). The G&A charges by MariQuest were treated as an operating expense for two reasons. The first is the large number of different costs categorized as G&A. The second is that the focal point of a demonstration analysis is the monthly cash flow, and treating G&A as overhead would have underestimated the cash needs.

Monthly cash flow analyses do not match monthly accounting records for two reasons. Some elements of the monthly demonstration project cost submissions may have reappeared in a subsequent month due to negotiations between MariQuest and WES. Also, the categories of costs kept by MariQuest did not correspond with those required by AQUADEC.

The major items on the property list were categorized to place them in an AQUADEC cost-recovery subroutine. Buildings were designated as property with a useful life of 20 years and a total value of $39,045. Machinery was differentiated from equipment. The former was assigned a useful life of 7 years and had a total value of $171,767. Equipment was given a useful life of 5 years and totaled $91,596.

Two crop years were analyzed, 1987 and 1988, but the demonstration project also produced shrimp harvests in 1989. A difficulty with the accounting system arose due to the expenditure of funds in 1988 for shrimp harvested in 1989. The accounting system was not designed to report expenses by crop. Consequently, an unknown amount of the expenses in late 1988 actually should be attributed to the 1989 shrimp harvest. The evaluation did not include an adjustment for this accounting inflexibility. This inflexibility also restricts the ability to analyze thoroughly and compare the extensive and semi-intensive crops. Shrimp crop information was recorded in the monthly reports prepared by MariQuest. These reports did not include accounting reports but did indicate expenses by crop for what MariQuest cited as key production costs. These include postlarvae, feed, diesel, harvest labor only, and processing costs. Total hours of Port Isabel staff were reported monthly, also.

Economics Analyses

Cash flow and crop budgets

A cash flow summary of the demonstration project is depicted by year for 1986 through 1988 in Tables 3 through 6.

The computer program used to analyze cash flow treats monthly negative cash balances as if an operating loan had been obtained. Consequently, interest payments for keeping the shrimp farm operating were incurred immediately. By December 1987, the accrued interest on the operating loan reached $44,233. It was not until that month that any receipts from shrimp sales were realized. This was the case in spite of two harvests from Pond A in 1987. Immediate sales would have reduced operating loan interest and produced an interest savings; however, the demonstration project did not function in this way. An actual commercial venture would have indeed faced the mounting operating loan principal and interest burden.

The most useful element of the cash flow tables is the Total Cash Operating Expense row. Total cash operating expenses for 1987 were $477,280 compared to sales of $37,979. Approximately $245,000 of the 1987 crop harvest was actually sold in 1988. If all 1987 production had been sold in 1987, the total sales of $283,304 would have been insufficient to cover cash operating expenses of $477,280 and prior year cash operating expenses of $59,040. Cash expenses of $1.89 were experienced for each dollar of sales. The comparative numbers for each of the years are evident in the cash flow tables.

Table 3
1986 Cash Flow Statement for CAAP Demonstration Project

OPERATING EXPENSES:	TOTAL	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL CASH INFLOW	0	0	0	0	0	0	0	0	0	0	0	0	0
Labor hired	22,915	0	0	0	0	0	0	0	0	0	7,896	7,883	8,016
Repairs & Maintenance	1,839	0	0	0	0	0	0	0	0	0	1	0	1,838
Rent/leases	5,031	0	0	0	0	0	0	0	0	0	1,880	1,580	1,571
Seed stock	31	0	0	0	0	0	0	0	0	0	0	,	31
General supplies	4,468	0	0	0	0	0	0	0	0	0	2,049	567	1,853
Subcontractors	0	0	0	0	0	0	0	0	0	0	0	0	0
General Admin.	8,842	0	0	0	0	0	0	0	0	0	2,365	3,509	2,938
Feed	0	0	0	0	0	0	0	0	0	0	0	0	0
Fuel	2,783	0	0	0	0	0	0	0	0	548	515	1,392	328
Fringe Benefits & tax	4,198	0	0	0	0	0	0	0	0	0	1,257	1,308	1,540
Other	8,913	0	0	0	0	0	0	0	0	0	4,764	1,692	2,317
TOTAL CASH OPERATING EXP.	59,840	0	0	0	0	0	0	0	0	548	20,785	17,161	20,626
PURCHASES & OTHER OUTFLOWS													
Purchased stock (expensed)	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery & equipment	0	0	0	0	0	0	0	0	0	0	0	0	0
Breed stock (capitalized)	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & improvements	0	0	0	0	0	0	0	0	0	0	0	0	0
Land purchases	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Cash Assets (outflow)	0	0	0	0	0	0	0	0	0	0	0	0	0
Owner withdrawals	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflows to savings	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflows to retirement acc	0	0	0	0	0	0	0	0	0	0	0	0	0
Inter & long-term loan pay	3	3	0	0	0	0	0	0	0	0	0	0	0
TOTAL CASH OUTFLOW	59,843	3	0	0	0	0	0	0	0	548	20,785	17,161	20,626
Ending cash bal. w/o loan		-3	0	0	0	0	0	0	0	-548	-20,785	-17,161	-20,626
OPERATING LOAN:	INTEREST %: 14.80%												
Operating loans needed	59,843	3	0	0	0	0	0	0	0	548	20,785	17,161	20,626
Interest pay. (oper. loan)	0	0	0	0	0	0	0	0	0	0	0	0	0
Principal pay. (oper. loan)	0	0	0	0	0	0	0	0	0	0	0	0	0
Ending cash balance	0	0	0	0	0	0	0	0	0	0	0	0	0
ACCRUED INTEREST (Beg. Mth.)		0	0	0	0	0	0	0	0	0	7	255	788
OPER. LOAN BALANCE (End Mth.)		3	3	3	3	3	3	3	3	551	21,256	38,417	59,843

Table 4
1987 Cash Flow Statement for CAAP Demonstration Project

OPERATING EXPENSES:	TOTAL	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL CASH INFLOW	0	0	0	0	0	0	0	0	0	0	0	0	0
Labor hired	100,673	6,562	3,458	17,777	7,879	8,412	8,412	10,506	4,588	4,746	14,045	9,364	4,924
Repairs & Maintenance	14,880	1,285	125	1,710	282	0	1,700	1,237	685	277	2,580	3,418	1,481
Rent/lease	10,925	600	0	4,325	600	600	1,200	600	600	600	600	1,200	0
Seed stock	81,161	0	0	40,880	21	7,080	215	0	30,894	0	0	0	31
General supplies	9,781	397	180	2,285	1,428	0	737	1,829	375	1,643	715	308	485
Subcontractors	72,522	0	0	682	784	0	436	0	329	6,821	40,130	141	24,069
General Admin.	86,852	4,921	0	11,547	4,887	7,825	17,984	7,813	4,717	7,886	11,611	6,188	3,370
Feed	36,334	0	0	0	0	0	0	11,520	33	11,467	0	516	12,788
Fuel	14,188	0	0	0	0	108	1,807	1,346	3,218	3,824	1,589	1,914	1,117
Fringe Benefits & tax	17,828	1,243	852	2,886	1,468	1,486	1,486	985	0	1,312	1,484	3,071	1,313
Other	33,119	1,123	192	4,875	9,516	0	4,888	180	1,857	2,387	4,163	3,182	1,798
TOTAL CASH OPERATING EXP.	477,288	16,141	4,816	80,726	26,150	25,429	38,707	34,263	45,866	38,568	77,107	29,357	51,173
PURCHASES & OTHER OUTFLOWS													
Purchased stock (expensed)	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery & equipment	263,349	131,679	0	0	0	0	0	131,670	0	0	0	0	0
Breed stock (capitalized)	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & improvements	30,845	30,845	0	0	0	0	0	0	0	0	0	0	0
Land purchases	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Cash Assets (outflow)	0	0	0	0	0	0	0	0	0	0	0	0	0
Owner withdrawals	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflows to savings	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflows to retirement acc	0	0	0	0	0	0	0	0	0	0	0	0	0
Inter & long-term loan pay	32,487	1,953	1,950	1,950	1,950	1,950	1,950	3,404	3,404	3,404	3,404	3,404	3,404
TOTAL CASH OUTFLOW	812,289	188,818	6,765	91,676	28,100	27,379	40,657	169,417	49,359	42,047	80,591	32,841	54,657
Ending cash bal. w/o loan		-93,871	-6,765	-91,676	-28,100	-27,379	-40,657	-169,457	-49,359	-41,876	-80,591	-32,841	-16,849
OPERATING LOAN:	INTEREST %: 12.00%												
Operating loan needed	613,445	93,871	6,765	91,676	28,100	27,397	40,657	169,457	49,359	41,876	80,591	32,841	16,849
Interest pay. (oper. loan)	0	0	0	0	0	0	0	0	0	0	0	0	0
Principal pay. (oper. loan)	0	0	0	0	0	0	0	0	0	0	0	0	0
Ending cash balance	0	0	0	0	0	0	0	0	0	0	0	0	0
ACCRUED INTEREST (Beg. Mth.)		1,536	3,865	4,662	7,176	9,970	13,888	14,513	21,023	21,826	31,440	37,676	44,328
OPER. LOAN BALANCE (End Mth.)		153,914	159,680	251,356	279,456	306,836	347,480	450,980	500,339	542,286	622,797	665,680	672,488

Table 5
1988 Cash Flow Statement for CAAP Demonstration Project

OPERATING EXPENSES:	TOTAL	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL CASH INFLOW	333,898	64,746	83,673	25,338	17,686	0	31	15	32,111	31	28,489	71,861	10,886
Labor hired	156,286	9,343	14,844	4,833	13,817	28,651	10,362	14,185	13,817	10,277	10,872	10,864	17,621
Repairs & Maintenance	83,126	0	4,812	386	6,927	11,397	2,613	3,994	6,927	7,784	4,649	18,491	12,936
Rent/lease	10,931	0	630	0	0	3,369	0	1,890	0	810	885	2,406	630
Seed stock	61,515	0	0	17,923	0	43,888	0	0	0	0	0	65	486
General supplies	4,462	0	606	99	740	994	0	0	740	428	529	2,339	237
Subcontractors	16,166	0	933	69	0	3,845	1,117	2,530	0	1,409	2,331	3,113	2,369
General Admin.	91,677	8,239	5,073	4,987	12,289	4,987	4,838	12,730	0	8,485	7,889	7,673	14,486
Feed	40,633	0	0	13,618	0	0	0	14,318	0	44	12,639	44	0
Fuel	25,495	71	1,478	1,151	2,125	4,225	3,482	1,592	2,125	4,237	6	3,861	922
Fringe Benefits & tax	36,640	2,844	2,365	1,482	2,994	4,789	2,224	3,929	2,994	1,783	3,445	3,179	4,881
Other	29,371	0	9,101	0	2,559	0	2,735	1,712	2,559	1,639	1,737	5,509	1,968
TOTAL CASH OPERATING EXP.	558,651	20,588	39,742	44,458	40,632	104,548	27,391	58,889	28,359	37,116	44,369	54,354	56,497
PURCHASES & OTHER OUTFLOWS													
Purchased stock (expensed)	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery & equipment	0	0	0	0	0	0	0	0	0	0	0	0	0
Breed stock (capitalized)	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & improvements	0	0	0	0	0	0	0	0	0	0	0	0	0
Land purchases	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Cash Assets (outflow)	0	0	0	0	0	0	0	0	0	0	0	0	0
Owner withdrawals	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflows to savings	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflows to retirement acc	0	0	0	0	0	0	0	0	0	0	0	0	0
Inter & long-term loan pay	41,811	3,487	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
TOTAL CASH OUTFLOW	600,462	23,985	43,226	47,942	44,106	108,032	30,875	62,373	31,837	40,600	47,747	59,838	59,881
Ending cash bal. w/o loan		40,761	40,447	-22,614	-26,500	-108,032	-30,874	-62,358	274	-40,569	-19,257	11,223	-48,895
OPERATING LOAN:	INTEREST %: 15.45%												
Operating loan needed	359,321	0	0	22,615	26,500	108,032	30,904	62,358	0	40,569	19,258	0	48,995
Interest pay. (oper. loan)	71,114	40,751	18,865	0	0	0	0	0	275	0	0	11,223	0
Principal pay. (oper. loan)	21,581	0	21,582	0	0	0	0	0	0	0	0	0	0
Ending cash balance	0	0	0	0	0	0	0	0	0	0	0	0	0
ACCRUED INTEREST (Beg. Mth.)		50,950	18,865	8,300	17,082	26,045	36,448	47,270	58,074	70,204	82,331	94,786	96,897
OPER. LOAN BALANCE (End Mth.)		672,480	650,907	673,521	700,021	808,085	838,985	901,315	901,315	941,885	961,143	961,143	1,000,227

Table 6
1989 Cash Flow Statement for CAAP Demonstration Project

OPERATING EXPENSES:	TOTAL	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
TOTAL CASH INFLOW	66,032	22,265	26,926	15,109	1,732	0	0	0	0	0	0	0	0
Labor hired	0	0	0	0	0	0	0	0	0	0	0	0	0
Repairs & Maintenance	0	0	0	0		0	0	0	0	0	0	0	0
Rent/lease	0	0	0	0	0	0	0	0	0	0	0	0	0
Seed stock	0	0	0	0	0	0	0	0	0	0	0	0	0
General supplies	0	0	0	0	0	0	0	0	0	0	0	0	0
Subcontractors	0	0	0	0	0	0	0	0	0	0	0	0	0
General Admin.	0	0	0	0	0	0	0	0	0	0	0	0	0
Feed	0	0	0	0	0	0	0	0	0	0	0	0	0
Fuel	0	0	0	0	0	0	0	0	0	0	0	0	0
Fringe Benefits & tax	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL CASH OPERATING EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0
PURCHASES & OTHER OUTFLOWS													
Purchased stock (expensed)	0	0	0	0	0	0	0	0	0	0	0	0	0
Machinery & equipment	0	0	0	0	0	0	0	0	0	0	0	0	0
Breed stock (capitalized)	0	0	0	0	0	0	0	0	0	0	0	0	0
Buildings & improvements	0	0	0	0	0	0	0	0	0	0	0	0	0
Land purchases	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Cash Assets (cash/flow)	0	0	0	0	0	0	0	0	0	0	0	0	0
Owner withdrawals	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflows to savings	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflows to retirement acc	0	0	0	0	0	0	0	0	0	0	0	0	0
Inter & long-term loan pay	41,811	3,457	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
TOTAL CASH OUTFLOW	41,811	3,457	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
Ending cash bal. w/o loan		18,808	23,442	11,625	-1,732	-3,484	-3,484	-3,484	-3,484	-3,484	-3,484	-3,484	-3,484
OPERATING LOAN:	INTEREST %: 14.00%												
Operating loans needed	29,626	0	0	0	1,732	3,484	3,484	3,484	3,484	3,484	3,484	3,484	3,484
Interest pay. (oper. loan)	53,874	18,808	23,441	11,625	0	0	0	0	0	0	0	0	0
Principal pay. (oper. loan)	0	0	0	0	0	0	0	0	0	0	0	0	0
Ending cash balance	0	0	0	0	0	0	0	0	0	0	0	0	0
ACCRUED INTEREST (Beg. Mth.)		100,864	101,842	90,187	90,348	102,154	114,004	125,909	137,817	149,786	161,796	173,846	185,957
OPER. LOAN BALANCE (End Mth.)		1,808,227	1,808,227	1,808,222	1,811,579	1,815,403	1,818,947	1,822,432	1,825,916	1,829,400	1,832,884	1,836,368	1,839,853

Some of the 1988 harvest was sold in 1989. As stated previously, some of the expenses listed in 1988 related to the last crop grown to maturity in 1989. The combined influence of more expenses in the 1988 table for the 1989 crop and some 1988 crop sales ($66,062) occurring in 1989 produced a major cash shortfall. The computer program thereby calculated an operating loan as it did for 1987.

The financial data were condensed and depicted as crop budgets for each of the operating years in Tables 7 through 10 as a means of conveying information to readers not concerned with cash flow.

The cash flow and crop budget tables quickly serve to identify the negative financial situation resulting from two demonstration crop years. Had the demonstration project been a commercial venture, it would have required investment capital to initiate the shrimp farm business and large operating loans would have been required afterwards. For purposes of initiating the analysis, the investment capital needed for start-up, buildings, machinery, and equipment was projected. The cash flow table for 1987 shows a new loan entry of $160,859 for the year. This was derived by assuming that a commercial venture must meet approximately one-half of its investment needs with equity capital. Because this was expended in 1986 as equity capital, there is no entry in the cash flow. One-half of machinery and equipment was to be borrowed funds with one-half needed in January and one-half needed in July (Table 4). Although this is somewhat arbitrary, it is consistent with the attempt to provide insight into differences between the demonstration project and a commercial venture. The funds borrowed to meet the building needs were received in January 1987. The total for buildings, machinery, and equipment needs from equity and borrowed sources totaled approximately $302,000.

Crop evaluations

The CAAP shrimp farm was a large-scale experiment in which different stocking and growout strategies were both demonstrated and tested. Analyses based solely on financial criteria would show only financial losses. To allow an analysis for comparison with private ventures, a crop evaluation approach was developed. This approach is less comprehensive but may be acceptable for identifying the specific favorable and unfavorable aspects of demonstration project crop production. Monthly accounting reports and growout summaries were used to approximate crop results in relation to important operating expenses. Crop comparisons for 1987 and 1988 were developed for this evaluation.

Table 11 shows the results of two crops from Pond A in 1987. The initial observation is that each crop was produced for similar costs, $2.18 versus $2.08 per pound of tails. The second crop was actually produced at a much lower cost than is evident from Table 11. The higher $0.23-per-pound cost for processing Crop 2 was due to approximately one-third of Crop 2 being processed and sold as PUD shrimp. Note, however, that the lower total cost of

Table 7
1986 Operating Budget for CAAP Demonstration Project

	TOTAL	FAC	UN.	$/POND	$/UN	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
Setup (2 pond facility)	0	1	lbs.	0	0.00	0	0	0	0	0	0	0	0	0	0	0	0
						QUANTITY											
OPERATING EXPENSES:																	
Labor hired	22,915	1	$/$	22,915	1.00	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	8,016
Repairs & Maintenance	1,839	1	$/$	1,839	1.00	0	0	0		0	0	0	0	0	1	0	1,838
Rent/leases	3,851	1	$/$	3,851	1.00	0	0	0	0	0	0	0	0	0	[illegible]	[illegible]	1,371
Seed stock	31	1	$/$	31	1.00	0	0	0	0	0	0	0	0	0	0	0	31
General supplies	4,448	1	$/$	4,448	1.00	0	0	0	0	0	0	0	0	0	2,048	567	1,832
Subcontractors	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
General & admin.	8,862	1	$/$	8,862	1.00	0	0	0	0	0	0	0	0	0	2,343	3,569	2,950
Feed	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
Fuel	2,783	1	$/$	2,783	1.00	0	0	0	0	0	0	0	0	548	515	1,392	328
Fringe Benefits & tax	4,198	1	$/$	4,198	1.00	0	0	0	0	0	0	0	0	0	1,257	1,398	1,543
Other	8,913	1	$/$	8,913	1.00	0	0	0	0	0	0	0	0	0	4,764	1,632	2,517
TOTAL EXPENSE	59,040			59,040													
NET RETURNS	(59,040)			(59,040)													

Table 8
1987 Operating Budget for CAAP Demonstration Project

Shrimp (2 pond facility)	37,797	1	lbs.	37,979	3.42	0	0	0	0	0	0	0	0	50	0	0	11,855
						QUANTITY											
OPERATING EXPENSES:	TOTAL	FAC	UN.	$/POND	$/UN	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
Labor hired	100,673	1	$/$	100,673	1.00	6,582	3,458	17,777	7,879	8,412	8,412	10,586	4,588	4,746	14,045	9,364	4,924
Repairs & Maintenance	14,880	1	$/$	14,880	1.00	1,286	125	1,710	282	0	1,780	1,237	655	277	2,580	3,618	1,401
Rent/leases	10,925	1	$/$	10,925	1.00	600	0	4,325	600	600	1,200	600	600	600	600	1,200	0
Seed stock	81,161	1	$/$	81,161	1.00	0	0	43,000	21	7,800	215	0	30,094	0	0	0	31
General supplies	9,683	1	$/$	9,683	1.00	379	180	2,285	1,428	0	737	1,029	575	1,643	715	288	455
Subcontractors	72,522	1	$/$	72,522	1.00	0	0	682	704	0	426	0	320	6,021	40,130	161	24,069
General & admin.	86,852	1	$/$	86,852	1.00	4,921	0	11,547	4,857	7,823	17,901	7,813	4,717	7,886	11,611	6,103	3,273
Feed	36,334	1	$/$	36,334	1.00	0	0	0	0	0	0	11,520	33	11,467	0	516	12,798
Fuel	14,103	1	$/$	14,103	1.00	0	0	0	0	188	1,807	1,346	3,218	3,024	1,569	1,914	1,117
Fringe benefits & tax	17,828	1	$/$	17,828	1.00	1,243	852	2,085	1,083	1,406	1,406	905	0	1,312	1,894	3,071	1,313
Other	33,119	1	$/$	33,119	1.00	1,123	192	4,875	9,516	0	4,803	189	1,057	2,387	4,163	3,102	1,792
TOTAL EXPENSE	477,280																
NET RETURNS	(438,301)																

Table 9
1988 Operating Budget for CAAP Demonstration Project

Shrimp (2 pond facility)	333,899	1	$/$	333,899	3.07	21,090	27,255	8,250	5,735	0	10	5	10,460	10	9,200	23,147	3,520
							QUANTITY										
OPERATING EXPENSES:	TOTAL	FAC	UN.	$/POND	$/UN	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
Labor hired	156,206	1	$/$	156,206	1.00	9,363	14,844	4,833	13,017	28,651	10,262	14,185	13,017	10,277	10,072	10,064	17,621
Repairs & Maintenance	82,126	1	$/$	83,126	1.00	0	4,812	396	6,927	11,397	2,613	5,994	6,927	7,784	4,649	18,691	12,936
Rent/lease	10,931	1	$/$	10,931	1.00	0	630	0	0	3,560	0	1,890	0	810	805	2,606	630
Seed stock	61,515	1	$/$	61,515	1.00	0	0	17,923	0	43,090	0	0	0	0	0	66	436
General supplies	6,662	1	$/$	6,662	1.00	0	606	99	740	904	0	0	740	428	529	2,359	257
Subcontractors	16,166	1	$/$	16,226	1.00	0	933	60	0	3,045	1,117	2,530	0	1,469	2,531	2,112	2,369
General & admin.	91,677	1	$/$	91,677	1.00	8,230	5,073	4,967	12,269	4,967	4,838	12,739	0	8,655	7,880	7,673	14,406
Feed	40,653	1	$/$	40,653	1.00	0	0	13,618	0	0	0	14,318	0	44	12,629	44	0
Fuel	25,495	1	$/$	25,495	1.00	71	1,478	1,151	2,125	4,225	3,602	1,592	2,125	4,237	6	3,961	922
Fringe Benefits & tax	36,649	1	$/$	36,649	1.00	2,844	2,265	1,402	2,994	4,709	2,224	3,929	2,994	1,703	3,445	3,179	4,881
Other	29,571	1	$/$	29,571	1.00	0	9,101	0	2,550	0	2,735	1,712	2,550	1,629	1,737	5,599	1,958
TOTAL EXPENSE	558,651																
NET RETURNS	(224,812)																

Table 10
1989 Operating Budget for CAAP Demonstration Project

Shrimp (2 pond facility)	66,062	1	lbs.	66,062	3.43	6,500	7,850	4,405	505	0	0	0	0	0	0	0	0
						QUANTITY											
OPERATING EXPENSES:	TOTAL	FAC	UN.	$/POND	$/UN	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
Labor hired	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
Repairs & Maintenance	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
Rent/leases	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
Seed stock	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
General supplies	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
Subcontractors	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
General & admin.	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
Feed	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
Fuel	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
Fringe Benefits & tax	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	1	$/$	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL EXPENSE	0			0													
NET RETURNS	66,062			66,062													

Table 11
1987 Crop Summary

	Crop 1		Crop 2	
	Totals	Cost Per Pound of Tails	Totals	Cost Per Pound of Tails
Harvest - Whole Shrimp - Pounds	106,037		48,425	
Harvest - Tails - Pounds	66,175		29,055	
Survival - %	74		56	
Majority Size - Tails	36 - 50		51 - 80	
Postlarvae Cost	$55,130	$0.83	$26,000	$0.89
Feed Cost	$39,688	$0.60	$8,273	$0.28
Diesel Fuel Cost	$6,284	$0.09	$1,335	$0.05
Harvest, Labor Cost	$4,081	$0.06	$936	$0.03
Processing Cost	$39,558	$0.60	$24,146	$0.83
Total Cost Per Pound		$2.18		$2.08

Crop 2 was for a smaller shrimp. This late-season crop incurred lower costs, in part, because smaller shrimp, in general, are cheaper to produce. Although smaller shrimp are regularly observed to have better feed conversion, the significantly lower feed cost for Crop 2 was related to colder weather when it was not feasible to feed.

The relative efficiency of these actual documented costs compared to other commercial operations could not be determined. Feed cost estimates by Lawrence, Johns, and Griffin (1984) and Parker (1988) were both $1.01 per pound of tails. The CAAP demonstration project results of $0.60 and $0.28 per pound of tails for feed are significantly enough below these published estimates to indicate a measure of success. The marked difference between the published estimates and the CAAP demonstration project costs was found in the cost per pound of postlarvae. The CAAP demonstration project showed a uniform cost of $0.83 to $0.89 per pound for postlarvae. This compares to $0.64 per pound (Lawrence, Johns, and Griffin 1984) and $0.55 per pound (Parker 1988). During the period when postlarvae were being purchased for stocking the demonstration project, the price of postlarvae fluctuated from $6.50 per thousand to $15.00 per thousand. The difference between actual demonstration project experience and reference estimates may not be real; however, it is the only comparison suitable from the general geographic area. The postlarvae cost per thousand was comparable with the exception of Crop 1. The purchase price cost per thousand for Crop 1 was twice that of Crop 2. However, Crop 2 had a higher cost per pound of production. The lower survival experienced in Crop 2 produced the higher effective cost.

Two crops were produced in 1988. A summary of that year's results is shown in Table 12. There were important differences between the 1987 crops and the 1988 crops. Crop 3, grown in Pond A, was the extensive trial that had a low stocking density. Crop 4, grown in Pond B, was a semi-intensive trial undertaken after the pond had received dredged material.

The January, 1989, narrative report by MariQuest noted disappointing results for the 1988 crops. In June, 130 mph winds occurred, and in September, hurricane Gilbert disturbed conditions late in the growout. The extensive trial in Pond A experienced significant mortality due to predation by sea trout. Pond B had fundamental problems from the start due to poor shipping of postlarvae and possibly due to disease. Crop 3, the extensive trial in Pond A, was not an economic success. Table 12 shows a total per pound cost of $8.53 for producing 2,785 lb of tails. The low number of shrimp harvested causes the postlarvae cost to be $6.43 per pound which would be an unacceptable production cost for a commercial operation. However, if the average postlarvae cost of $0.97 per pound of Crop A in Pond B were substituted for the $6.43 per pound cost, the total per pound production cost for shrimp from Crop 3 would have been $2.11. The extensive management approach used for Crop 3 was successful at producing a limited crop of large shrimp with no feed cost. The feed cost can be one of the three highest production costs along with postlarvae and harvest costs. Those shrimp that did survive until harvest were some of the largest produced at the demonstration project. This could indicate

Table 12
1988 Crop Summary

	Crop 3		Crop 4	
	Totals	Cost Per Pound of Tails	Totals	Cost Per Pound of Tails
Harvest - Whole Shrimp - Pounds	4,504		70,460	
Harvest - Tails - Pounds	2,785		44,390	
Survival - %	3.4		50.6	
Majority Size - Whole	16 - 35		41 - 70	
Postlarvae Cost	$17,923	$6.43	$43,090	$0.97
Feed Cost	0	0	$36,507	$0.82
Diesel Fuel Cost	$1,030	$0.37	$16,424	$0.37
Harvest, Labor Cost	$2,827	$1.02	Not Available	$0.53[1]
Processing Cost	$1,990	$0.71	$31,725	$0.71
Total Cost Per Pound		$8.53		$3.40

[1] Harvest Labor Cost data were not available for Crop 4. $0.53 is a weighted average from Crop 1 and Crop 2.

that for many containment areas, extensive management is perhaps the best alternative. (It must be noted that the "total" entries of Tables 11 and 12 are totals of only the cost entries in the tables. The prior cash flow tables indicate that there were other expenses.)

Crop 4, the semi-intensive effort in Pond B, can be compared to the 1987 crops. Postlarvae costs were higher per pound because mortality resulted in fewer pounds of harvested shrimp to cover the postlarvae expense which had been incurred at the reasonable price of $8.80 per thousand. Feed and diesel costs were significantly higher on a per-pound basis than the costs of feed and fuel for Crop 2 in 1987. Crop 4 in 1988 resulted in a tripling of per-pound feed costs over that of Crop 2 in 1987. These two growout efforts had similar survival rates and produced shrimp of similar size. However, the total critical costs of $2.87 per pound for Crop 4 exceeded the market prices for the shrimp produced. This situation will be separately analyzed for 1987 and 1988 in the following section on marketing.

As has been pointed out previously, the demonstration project provided an opportunity to examine different options for stocking, management, and production. The two crops produced in Pond A in 1987 were the closest to actual commercial practices and can be used to evaluate the economic potential of aquaculture in a DMCA. Crops 1 and 2 could represent a production year in an ongoing business. To evaluate economic potential, yield and production costs can be compared to values from aquaculture literature. This is, of course, a limited comparison that shows selected production costs and ignores start-up costs associated with the first year of the demonstration project. On a physical yield basis, the two harvests from Pond A in 1987 produced 154,462 lb of whole shrimp. This represents a yield of 1,485 lb per acre. Because 75 percent of the shrimp consumed in the United States are imported, comparison to foreign aquaculture operations is relevant. R. Rosenberry (1990) reports in the September/October 1990 issue of *Aquaculture Magazine* that the average yield for farmed shrimp from Mexico is 765 lb per acre, from Ecuador it is 593 lb per acre, and the Western Hemisphere average is 2,654 lb per acre.

Texas A&M researchers Hollin and Griffin (1985) used a yield of approximately 950 lb per acre of whole shrimp in analyzing a hypothetical Texas farm of 20 ponds of 25 acres each with one harvest per year. For a 20-acre pond in South Carolina, Pomeroy[1] used a yield of 250 lb per acre of whole shrimp. It is apparent from these figures and the demonstration project yield of 1,485 lb per acre that containment area aquaculture has the potential for at least limited success.

Mainland U.S. shrimp aquaculture occurs principally in south Texas and in South Carolina. Shrimp research data from these two states are available in

[1] R. S. Pomeroy. (1990). "Estimated costs of marine shrimp in one 20-acre existing ricefield impoundment, South Carolina, 1990" (personal communication).

the aquaculture literature and provide comparative data for yields as well as production costs.

From the previously cited references for Texas and South Carolina, selected production costs from the demonstration project are compared in Table 13 to similar costs for producing farm-raised shrimp from hypothetical aquaculture operations in these two states. The South Carolina example is based on the experience of shrimp farmers and researchers using existing rice field impoundments for shrimp ponds. Due to the more northerly latitude, South Carolina aquaculturists attempt only one crop per year. All of the per-pound production costs from the demonstration project used for comparison are reasonably close to those theoretical values used by South Carolina researcher Pomeroy.

The Texas example represents a large "agribusiness" shrimp farm of over 500 acres and provides contrast with the smaller South Carolina pond of 20 acres. With the exception of fuel costs, the labor, postlarvae, and feed costs incurred at the containment area site agree well with the theoretical costs chosen by Texas researchers Hollin and Griffin (1985).

Some of the difficulties of comparing harvest and production costs figures for U.S. aquaculture arise because there are relatively few companies producing cultured shrimp and there is no domestic reporting system that provides a reservoir of data. Moreover, the data that are available reflect the trends in U.S. shrimp farming toward smaller ponds of 5 to 20 acres each and higher intensity management of more densely stocked animals. The expectation is that with smaller ponds, closer management is possible. The demonstration project ponds were considerably larger than those used for comparison of harvest figures. The respectable yield of 1,485 lb per acre may attest to the skills of the demonstration project managers, but the large pond size makes comparisons to figures from research literature less direct. Nevertheless, the Brownsville shrimp farm thus demonstrated that aquaculture in a DMCA is quite feasible, based on both yield and production costs.

Marketing Analyses

Marketing decisions can have as great an impact on profits as operation and production decisions. One of the critical choices made early in planning the demonstration project was the decision to raise shrimp. Other critical decisions made prior to harvests involved the timing of shrimp sales and the forms of the shrimp products to be sold. All of these decisions were influenced by the national and worldwide shrimp markets.

Table 13
Comparison of CAAP Demonstration Project to Hypothetical U.S. Shrimp Aquaculture Facilities

	Containment Area Aquaculture Program Demonstration Project Actual Values		South Carolina Ricefield Impoundment[1] Theoretical Values		Texas Shrimp Mariculture Facility[2] Theoretical Values	
Pond Size	One 104-acre pond		One 20-acre pond		Twenty 25-acre ponds	
Number of Crops	2		1		2	
Total Yield (tails)	95,230 lb		3,150 lb		761,115 lb	
Per Acre Yield	915 lb		158 lb		1,522 lb	
	Total Cost	Per Pound Cost	Total Cost	Per Pound Cost	Total Cost	Per Pound Cost
Feed Cost	$47,961	$.50	$2,063	$.66	$351,554	$.46
Labor Cost (includes harvest)	$48,949	$.51	$2,460	$.78	$115,360	$.15
Fuel Cost	$7,619	$.08	$300	$.10	$10,300	$.01
Postlarvae Cost	$81,130	$.85	$2,000	$.63	$618,000	$.81

1 Fifty percent survival of postlarvae stocked at [illegible],000 per acre directly into growout pond. Harvest includes ice and boxes (Pomeroy, personal communication, 1990).

2 Fifty percent survival of postlarvae stocked at 40,000 per acre into nursery ponds (Hollin and Griffin 1985).

Recent shrimp market history

The CAAP demonstration project began in 1986. Shrimp supply and markets prior to that time were the impetus for consideration of domestic shrimp aquaculture investments. The 1980's to that point had been a period of renewed consumer interest in the health aspects of seafood. Development of shrimp farming businesses in South America and Asia was frequently reported in trade and general-public-oriented publications. A common element of descriptions in the published material was that the domestic shrimp fishery was mature and fully developed. Shrimp supply from domestic-capture fisheries was thought to be in a no-growth phase. All grounds had been discovered and fished to full capacity. It was assumed that profitable aquaculture would occur due to the constraint on domestic supply and increasing seafood consumption. Aquaculture of shrimp arose as a potentially new element in the supply side of the market, and supplies from aquaculture sources exerted more influence than corresponding poundage increases from natural fisheries.

Table 14 shows in millions of pounds the quantities of shrimp in inventory, the quantities landed (includes cultured), and the quantities imported. From 1950 to 1988, the U.S. shrimp supply increased by 4.2 percent annually. However, during the recent period from 1980 to 1988, the growth rate in supply increased 5.8 percent annually. Domestic production during this recent period did not increase. Essentially all new supplies required to satisfy the increased consumer interest in seafood came from import sources. It was an additional 340 million pounds of imported shrimp that the prospective domestic shrimp farm investor in the mid-1980's would have had to contend with in a quest for profits.

A noteworthy result of the shrimp supply increase was the relatively diminished role of inventories in the shrimp industry. From Table 14, it is evident that as import supplies increased, inventories did not build. It had been a characteristic of the U.S. shrimp industry that annual inventories would be built late in the year for marketing during winter months. Generally, the buildup of inventories was rewarded with higher winter and Lenten-season prices. However, the greater degree-of-supply certainty arising from foreign aquaculture sources diminished the need and incentive for late-year storage. Storage and resale now occurs more to meet the needs of wholesalers. More shrimp were marketed each year without beginning inventories (January) showing a related increase. The shrimp market became more "current" as a result of large supplies coming from countries developing their aquaculture potential.

This marketing situation was characterized by increasing supplies being sold more quickly and directly. Shrimp sales reflect consumption in the United States. Figures from 1960 through 1988 are shown in Table 15. Shrimp consumption trends have been upward in response to both favorable economic conditions in the 1980's and rising availability. The pace of shrimp supply growth (5.8 percent annually) clearly outstripped the country's annual population increase of only 1 percent. Inventories failed to build which indicated that prices and promotions were being used to keep the market

Table 14
United States Shrimp Supply, 1950-1988

Year	Millions of Pounds			
	Beginning Inventory	Landings	Imports	Total
1950	16	121	44	181
1955	32	154	60	246
1960	48	156	125	329
1965	49	152	181	382
1970	69	224	249	542
1975	82	209	232	523
1976	54	246	272	572
1977	72	288	272	632
1978	94	257	240	591
1979	65	206	269	540
1980	88	208	258	554
1981	78	219	259	556
1982	65	176	320	561
1983	58	156	421	635
1984	71	188	422	681
1985	61	207	452	720
1986	62	244	492	798
1987	59	224	483	866
1988	67	203	498	868

NOTE: The total column represents total supply prior to accounting for end inventory and a small amount of exports.

unburdened. Even the favorable national economic situation could not prevent a negative impact on prices. Following the 100,000,000-lb import increase of 1983, a generally unfavorable price trend confronted aquaculture investors by 1985-86. Since that time, the importation of white shrimp from China has increased. Most of the Chinese farmed shrimp were in the 41-60 count sizes, thereby resulting in a price decrease in 1988. Even larger shrimp are not insulated from price weakening. In 1989, prices for the 30-count and larger shrimp were much lower. Major increases in the supply of farm-raised tiger shrimp from Indonesia, Thailand, and the Philippines resulted in a decrease in production from other countries.

Marketing the demonstration project shrimp

Revenue generation for the demonstration project was not a simple matter of pricing the harvest. As the cash flow tables indicate, sales were from frozen inventories. The sales from 1987 occurred primarily in 1988. This

Table 15
United States Per Capita Shrimp Consumption, 1960-1988

Year	Pounds/Capita
1960	1.1
1965	1.2
1970	1.4
1975	1.4
1980	1.4
1981	1.5
1882	1.5
1983	1.7
1984	1.9
1985	2.0
1986	2.2
1987	2.3
1988	2.4

includes Crop 1 production harvested in September 1987 and likely sold primarily as shell-on frozen headless in January and February of 1988. The Crop 2 production included the sale of two shrimp forms, shell-on frozen headless and PUD. Approximately one-third of the Pond 2 harvest was processed into PUD shrimp. The sales records used to identify the timing of sales generally were not conducive to differentiating between 1987 crops. However, the one-third of Pond 2 production that was peeled was essentially all of that form associated with the 1987 yield. Only 330 lb of PUD shrimp were processed from the first crop. With this information, the 1987 shrimp crop sales reports could be used to identify when PUD shrimp (i.e. Crop 2) were sold.

The size distribution of shrimp for each crop is indicated in Table 16. The extensive approach of Pond A in 1988 produced the largest shrimp. Crop 1 in 1987 had the next largest shrimp followed by Crop 2 in 1987 and Crop 4 in 1988 with similar sizes.

The total revenue from shrimp sales is a result of the size mix and the prevailing price. The prevailing price was reviewed from two perspectives. First, prevailing prices during the month of harvest and the period of sale were developed from published sources. The second price perspective is the price at ex-vessel and wholesale. This perspective identifies whether or not a price over wild supplies was received. The total revenue then depends on the size distribution (Table 16) and dates of sales. Shrimp prices are directly related to size with larger shrimp bringing higher prices. The domestic shrimp market is affected by a complex set of international factors. Imported shrimp can provide as much as 70 to 75 percent of supply. Fluctuations and uncertainty in

Table 16
CAAP Demonstration Project Shrimp Production and Size Distribution

Tail Size (Number/Pound)	1987		1988	
	Crop 1 %	Crop 2 %	Crop 3 %	Crop 4 %
U 16	0	0	5.3	.01
16-20	0	0	31.4	0
21-25	0	0	1.1	.01
26-30	.1	0	9.5	.01
31-35	3.8	2.0	42.3	.6
36-40	29.4	13.3	7.9	5.5
41-50	47.9	4.5	.9	32.0
51-60	16.3	10.6	.3	34.9
61-70	1.6	12.3	.2	16.0
71-80	.4	26.5	0	4.0
80+	.5 100.0	30.8 100.0	1.1 100.0	6.7 100.0
Total Pounds	66,175	29,055	2,785	44,390

international shrimp supplies have made the practice of delaying domestic sales more risky for shrimp harvesters.

Crop 1 of 1987 could not be specifically identified when sold because of recordkeeping procedures. Table 16 shows that the predominant sizes harvested were the 36-50 count. The 1987 Crop 1 disposition record indicated that most of these shrimp would have been sold in December 1987 and January/February 1988. A similar comparison for Crop 2 (December harvest) and the sales record indicate that most of these shrimp were likely sold in August and October of 1988. The October sales were predominately PUD shrimp. It is noteworthy from a marketing perspective that Crop 3 had a 10 percent stocking of *P. stylirostris*. Harvest size distribution shown in Table 16 indicates a larger average size shrimp. Shrimp farm managers reported that the larger shrimp were *P. stylirostris* and represented 80 percent of the crop value. A comparison of selected sale date prices received and a reference wholesale price standard from New York were made and reported in Table 15.

The New York reference price should be approximately $0.10 per pound higher to reflect transportation expenses. In general, the demonstration project received prices for shell-on frozen headless shrimp that were comparable to New York prices (Table 17). Crop 2 of 1987 produced approximately 10,000 lb of shrimp in headless categories 71-80 and 80+. Because of the small size, MariQuest had these processed into PUD shrimp as a means of gaining higher revenue. This choice actually produced a substantial loss. A higher processing cost was incurred for the peeling, and additional cost was

Table 17
CAAP Demonstration Project Prices Received for Shrimp

Selected Sale Date	Selected Size Category	Price Received Per Pound	New York Wholesale Price
December, 1987	36-40	3.50	3.60
January, 1988	31-35 36-40 41-50	4.40 3.55 3.10	4.65 3.75 3.30
February, 1988	36-40 41-50	3.70 3.29	3.90 3.30
March, 1988	51-60	3.00	2.85
April, 1988	51-60	2.79	3.00
August, 1988	61-70 71-80	2.25 1.90	2.35 2.10
October, 1988	90-110 PUD 110-130 PUD 130-150 PUD	2.37 2.21 1.98	3.15 3.30 2.30
November, 1988	41-50 51-60	3.35 3.12	3.80 3.15
January, 1989	51-60	3.15	3.30
February, 1989	31-35 61-70	4.85 2.85	4.90 2.90

incurred when the shrimp were placed in storage for 9 to 10 months. Table 18 indicates that the PUD shrimp were predominately in the 90+ size category. Actual prices received in October 1988 were in the range of $1.98 to $2.37 per pound. Ex-vessel prices for shell-on tails in December 1987, the date of Crop 2 harvest, were in the $1.80 to,$2.35 range. Thus, processing costs could have been saved on the 10,000 lb at a savings of approximately $0.25 per pound. It should be noted that PUD shrimp prices at the time the shrimp were processed were much higher. The PUD shrimp price range was $3.55 to $3.85 in December 1987, thus prompting the decision to have the small shrimp processed. Shrimp farm management reported that by the time of sale in October 1988, prices had been falling progressively and almost no PUD shrimp were being sold in the south Texas market at any price. The average PUD shrimp price was $1.59 per pound higher at harvest than at the date of sale. The result was a total foregone revenue of approximately $16,000.

The comparisons of ex-vessel fresh prices and New York wholesale frozen prices at the time of harvest with wholesale frozen prices received by MariQuest (Tables 17 and 18) indicate that favorable marketing results were achieved. While there were some exceptions, notably the PUD shrimp choice, most sales of frozen shrimp tails paid for the processing costs. Selling processed frozen tails was a better choice than selling at ex-vessel fresh prices.

Table 18
CAAP Demonstration Project Prices of Ex-Vessel and Wholesale Headless Shrimp Prices Prevailing at Harvest

	Ex-Vessel[1] Fresh	Wholesale[2] Frozen
Crop 1 - September, 1987		
36-40	$2.95	$3.70
41-50	$2.60	$3.35
51-60	$2.55	$3.25
Crop 2 - December, 1987		
51-60	$2.60	$3.05
61-70	$2.50	$2.95
71-80	$1.85	$2.75
Crop 3 - November, 1988		
16-20	$6.13	$8.00
21-25	$5.13	$7.10
26-30	$4.95	$5.75
31-35	$4.05	$4.75
Crop 4 - November, 1988		
36-40	$3.45	$4.15
41-50	$3.25	$3.80
51-60	$2.45	$3.15
61-70	$2.00	$2.95

[1] Ex-vessel western Gulf of Mexico reported by the National Marine Fisheries Service (NMFS).
[2] Wholesale prices ex-warehouse New York reported by NMFS.

The speculation with the small shrimp processed as PUD's resulted in sales approximately $16,000 lower than sale immediately at wholesale frozen prices. This speculation represented an unfortunate marketing decision but resulted in an important lesson being learned.

Conclusions from Demonstration Project

Although the demonstration project was a commercial-scale operation, it was not designed as a commercial operation would be. Existing aquaculture technology for smaller ponds was adapted to the demonstration site where existing containment areas of over 100 acres each already existed. Despite this origin, the project met the purposes for which it was established and generated much new information to give perspective for future aquaculture in DMCA's.

The project did reveal a significant value to the lowered start-up or entry costs. Containment area levee cost estimates by the USAED, Galveston, were $1,600 and $900 per acre for Pond A and Pond B, respectively. When compared to aquaculture literature, these values appear closer to the per-acre value for smaller ponds. The demonstration project ponds were 100+ acres each but were compared to cost data from the literature for smaller ponds near 20 acres each. Engineering, surveying, designing, and permitting work, if performed by the USACE, could be worth $400 per acre. For the demonstration project, the combined capital savings was estimated to be $271,000. The annual drain on

cash flow of the estimated $271,000 start-up capital needs would have been $63,000.

In an industry known for scarcity of funds available from financial institutions, this capital savings is both real and valuable. Investors characteristically provide a high share of an aquaculture project's start-up capital because most projects lack full institutional support. Not only could the lowered immediate demand on cash outflow increase chances for company success, but a DMCA aquaculture venture would be available to a wider number of prospective companies. This is an outlook which will be of value not just to large containment areas like those at the demonstration project, but to smaller sites suited to more intensive operations or part-time operators.

The value to a new aquaculture facilty's investor(s) of DMCA use is, up to now, unquantified. Whatever quantification there could be will produce site-specific numbers. The USACE and aquaculture companies have similar needs for accessible sites, perimeter levees, containment areas (ponds) of various sizes, water-retaining soils, and water control in impoundments. When these needs can be met on a site that is technically conducive to aquaculture, an economic opportunity exists.

The major potential investment-reducing incentive to use a DMCA is the pond construction cost. Parker (1988) identified coastal pond construction costs of $1,000 per acre in Texas. Catfish farm levee costs are also well documented. Keenum and Waldrop (1988) provide an estimate for catfish pond construction of $840 per acre. This estimate was reflective of eight ponds of 17 acres each in a system. Wet soils of coastal areas and the remoteness of sites could make DMCA projects more costly. The large pond size of the demonstration project made construction costs lower on a per-acre basis. Use of a pond construction value to prospective culturists of $800 per acre for DMCA culture appears to be a reasonable point for reference.

There is also value to reducing investment capital needs for engineering, designing, surveying, and permitting. To the extent that the USACE, or ports and waterway districts provide these services, an additional value of $400 per acre could occur. Using estimates of investment needs from the aquaculture literature, a combined value for pond engineering, design, surveying, permitting, and construction of $1,200 per acre can be justified.

For the approximately 230-acre CAAP demonstration project, this amounts to $271,000. The reduction of investment capital needs may be as important to increasing lender support as it is to lowering break-even costs since capital availability is a well known constraint in the aquaculture industry.

4 Development of DMCA Model

Purposes and Requirements

Once the demonstration project was established and produced real-world data, specific start-up costs and crop returns were identified and quantified. These demonstration results were then used in formulating a computer model that allows a user to "test" the economic feasibility of raising various animals in DMCA's of different sizes.

The primary objective of the DMCA model is to provide a spreadsheet template with the features necessary to input specific data, perform "what-if" scenarios, and obtain calculated results which will enable the user to make sound economic and marketing decisions which must be considered prior to starting an aquaculture business.

Specific requirements of the model were to:

a. Be useful to USACE district personnel, landowners, and aquaculturists, none of whom are experts at both dredging and aquaculture.

b. Be flexible to analyze selected variables that may be peculiar to certain species in different parts of the country.

c. Separate expenditures of the aquaculturist and the USACE district.

d. Be PC-compatible, portable, and designed for the novice PC user to operate with a minimum amount of computer knowledge.

After reviewing several economic models (Chapter 6) and because of the unique nature of DMCA aquaculture, a special model was developed and tested with existing data from the field demonstration to identify specific start-up investments, variable and fixed costs, and potential crop returns over a specified period of time. The final analysis of the worksheet provides the aquaculturist with the differences in annual expenses, net income/loss, and cash balance figures with and without financial assistance from the USACE district.

This model is not a substitute for the in-depth analyses of an aquaculture business that would be required by a lender or a financial backer. Neither is it an accounting system. It is, however, a good means for making an initial appraisal of the economic feasibility of a project.

Model Design

The DMCA spreadsheet model (Economics and Marketing Worksheets) is a combination of six worksheets developed with Lotus 1-2-3, a software product of the Lotus Corporation. The worksheets accept and calculate data for:

a. Construction costs.

b. Initial investment costs.

c. Annual variable costs.

d. Annual fixed costs.

e. Annual sales summary.

f. Annual income statement and annual cash balance statement.

The spreadsheet format will accept initial input, perform required calculations, and update figures from pp 1 to 6 of the Economics and Marketing worksheets. Once the worksheets are filled in, individual or multiple parameters can be changed, and the results of these changes can be viewed immediately. This is a significant advantage of the spreadsheet format. However, the six worksheets are designed so that they can be used without the computer performing all of the calculations.

The worksheets require the user to input a number of cost figures. These figures may have to be estimates, as in the length of a pond levee, or they may require some research into typical values from aquaculture literature or experts. Examples of these are the cost of fingerlings or the number of pounds of a species that may be harvested per acre.

Although the worksheets require considerable input, they are structured to assist the potential aquaculturist in initiating a thorough preproject evaluation. Standard financial analysis concepts are incorporated to prompt the user to consider the full range of factors and to appreciate their relationships.

This computer model is not comparable to programs such as AQUADEC which took many months or years to develop. It does not perform complex calculations nor does it account for such things as declining rates of depreciation or interest. Further, it will not, by itself, calculate multiyear scenarios.

Explanations of the use of the individual worksheets follow, but two applications will be mentioned at this point. For analyzing a crop that requires 2 years before harvest, the user may have to run the model twice to calculate annual costs that would be incurred prior to sale of the product. Each year of operation should be different for many of the variable costs and similar for many of the fixed costs. This would be true of analyzing a hybrid striped bass operation or a clam farm. For analyzing the effects of periodic material disposal by the local USACE district, the model can be run once for each year during which aquaculture would occur and once for a year of disposal. Income and expense figures can then be added and averaged to determine the effect of a missed opportunity to harvest and sell a crop.

Appendix A provides a copy of the User's Guide to the Economics and Marketing Worksheets and displays results of worksheet analyses of selected species (Chapter 5).

The worksheets are illustrated on the following pages as figures, parts a through f, and are accompanied by a brief explanation of the contents of each worksheet.

The economics computer model developed to analyze DMCA aquaculture operations is available on diskette from:

Program Manager
Containment Area Aquaculture Program
CE-WES-ER-C
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, Mississippi 39180-6199

Species CONSTRUCTION COSTS

DIRT VOLUME per LINEAR FOOT CALCULATION

A = TOP Width	______	Ft.	<-Insert
B = BASE Width	0	Ft.	B = (S1+S2) x H + A
H = HEIGHT	______	Ft.	<-Insert
S1 = INNER SLOPE	______	Ft.	<-Insert
S2 = OUTER SLOPE	______	Ft.	<-Insert

DIRT VOLUME AND COST CALCULATIONS

VOLUME = 0 CU. FT. per LINEAR FT. (A + B)/2 x H

LENGTH = ______ LINEAR FT. <-Insert

TOTAL VOLUME = 0 CU. YD. (VOLUME x LENGTH / 27)

DIRT MOVING COST: ______ PER CU. YD. <-Insert

USCOE'S CONSTRUCTION COSTS

A. LEVEE (Dirt Moving) COST	$0	(Dirt Moving Cost x Total Volume)
B. WATER CONTROL STRUCTURE(S)	______	<-Insert
C. ACCESS ROAD	______	<-Insert
D. PRECONSTRUCTION COSTS (permits, tests, etc.)	______	<-Insert
USCOE'S Total Construction Costs (A, B, C, D)		$0

AQUACULTURIST'S CONSTRUCTION COSTS

E: POND IMPROVEMENTS (seeding, shaping, etc.)	______	<-Insert
F. SITE IMPROVEMENTS & UTILITIES (piers, pilings, septic system, electricity, water, etc.)	______	<-Insert
G. PRECONSTRUCTION COSTS (permits, tests, etc.)	______	<-Insert
H. CONSTRUCTION SUPERVISION	______	<-Insert
Aquaculturist's Total Construction Costs (E, F, G, H)		$0
USCOE & AQUACULTURIST'S TOTAL CONSTRUCTION COSTS		$0

Figure 1. Example of CAAP Economics and Marketing Worksheet (Sheet 1 of 6)

The Construction Costs worksheet performs initial calculations on levee costs. The specifications for levees in aquaculture may vary considerably by species. In addition, the size of a DMCA will likely determine the length of levee that must be built. The worksheet separates those costs that would be incurred by the CE district from those that would be incurred by the aquaculturist. It is expected that each will bear some costs related to obtaining the necessary local, State, or Federal permits and authorizations.

Species INITIAL INVESTMENT COSTS

EQUIPMENT COSTS		
AERATOR & SCREEN	________	<-- Insert
BOAT & MOTOR	________	<-- Insert
BUILDING (Feed Storage)	________	<-- Insert
BUILDING (Office/Service)	________	<-- Insert
CHEMICALS	________	<-- Insert
COOLERS	________	<-- Insert
FEED BINS	________	<-- Insert
FEEDERS	________	<-- Insert
FLOATS	________	<-- Insert
GENERATORS	________	<-- Insert
HARVEST BASKETS	________	<-- Insert
HARVEST MACHINE	________	<-- Insert
MESH BAGS	________	<-- Insert
MOWER	________	<-- Insert
NETS	________	<-- Insert
NIGHT LIGHTS	________	<-- Insert
PUMP SHED	________	<-- Insert
TRAILER	________	<-- Insert
TRAPS	________	<-- Insert
VALVES	________	<-- Insert
VEHICLES	________	<-- Insert
WATER PIPE	________	<-- Insert
WELL & PUMPS	________	<-- Insert
WET SUIT / SCUBA	________	<-- Insert
OTHER: Miscellaneous	________	<-- Insert
OTHER: ________	________	<-- Insert
OTHER: ________	________	<-- Insert
OTHER: ________	________	<-- Insert
TOTAL EQUIPMENT COST	$0	

INITIAL INVESTMENT COSTS SUMMARY			
Aquaculturist's Investment Costs			
Total Equipment Costs	$0		
Total Construction Costs (Page 1):	0		
Total Investment Costs		$0	
USCOE'S Investment Costs			
Total Construction Costs (Page 1)		$0	
Total Aquaculturist's & USCOE'S Initial Investment Costs			$0

Figure 1. (Sheet 2 of 6)

The Initial Investment Costs worksheet identifies many standard items that must be purchased prior to start-up of an aquaculture project. Page 2 of the Economics and Marketing worksheet ends with a total of all investment costs, including sums carried from p 1 of the worksheet.

Species ANNUAL VARIABLE COSTS

VARIABLE PRODUCTION COSTS

BAIT	______	<--Insert
CHEMICALS	______	<--Insert
FEED	______	<--Insert
FERTILIZER	______	<--Insert
FINGERLINGS / POSTLARVAE	______	<--Insert
FUEL	______	<--Insert
HARVESTING	______	<--Insert
HAULING	______	<--Insert
HIRED LABOR & PAYROLL TAX	______	<--Insert
ICE	______	<--Insert
MANAGER	______	<--Insert
PROCESSING	______	<--Insert
REPAIRS & MAINTENANCE	______	<--Insert
SACKS	______	<--Insert
SEED	______	<--Insert
SUPPLIES	______	<--Insert
TRANSPORTATION	______	<--Insert
UTILITIES (Electricity, Telephone, Etc.)	______	<--Insert
OTHER: ______	______	<--Insert
OTHER: ______	______	<--Insert
OTHER: ______	______	<--Insert
OTHER: ______	______	<--Insert
A. SUB-TOTAL VARIABLE COSTS	$0	

OPERATING LOAN COSTS

B. % of Variable Costs Borrowed	______	<--Insert
C. Total Amount of Operating Loan	$0	(A x B)
D. Term of Operating Loan (Years)	______	<--Insert
E. Annual Operating Loan Payment	NA	(C / D)
F. % of Interest on Operating Loan	______	<--Insert
G. Interest Paid on Operating Loan	$0	(C x F)
H. TOTAL VARIABLE COSTS	$0	(A + G)

Figure 1. (Sheet 3 of 6)

The Annual Variable Costs worksheet identifies those costs that fluctuate yearly based on production of a crop. Like other farming activities, many aquaculture businesses borrow a portion of their operating funds either for a fixed number of years or based on a production cycle with the principal due following harvest. *The interest on this loan is a variable cost that is* accounted for with other variable costs. (Principal repayment is accounted for on p 6 of the Economics and Marketing Worksheet.)

Species ANNUAL FIXED COSTS

AQUACULTURIST'S EXPENDITURES / DEPRECIATION

A.	Total Investment Costs	$0	(From Page 2)
B.	Amortization Schedule (Years)		<--Insert
C.	Annual Investment Depreciation	NA	(A / B)
D.	% of Initial Investment Borrowed		<--Insert
E.	Amount of Investment Loan	$0	(A x D)
F.	Term of Loan (Years)		<--Insert
G.	Annual Principal Payment	NA	(E / F)
H.	% of Interest on Investment Loan		<--Insert
I.	Interest Paid on Investment Loan	$0	(E x H)
J.	Annual Insurance Premiums		<--Insert
K.	Salaried Employees and Payroll Taxes		<--Insert
L.	Miscellaneous		<--Insert
M.	Other ______		<--Insert
	TOTAL FIXED COSTS	NA	(C+I+J+K)

AQUACULTURIST'S FIXED COSTS SAVINGS
(Based on Value of USCOE'S Contribution to Total Construction Costs)

AA.	USCOE'S Total Construction Costs	$0	(From Page 1)
BB.	Amortization Schedule (Years)	0	(B above)
CC.	Annual Investment Depreciation	NA	(AA / BB)
DD.	% of Initial Investment Borrowed	0%	(D above)
EE.	Total Amount of Investment Loan	$0	(AA x DD)
FF.	Term of Loan (Years)	0	(F above)
GG.	Annual Principal Payment	NA	(EE / FF)
HH.	% of Interest on Investment Loan	0%	(H above)
II.	Interest Paid on Investment Loan	$0	(EE x HH)
	AQUACULTURIST'S FIXED COSTS SAVINGS	NA	(CC + II)

Figure 1. (Sheet 4 of 6)

The Annual Fixed Cost worksheet identifies those costs that must be paid regardless of harvest success or failure. The aquaculturist's annual costs are separated from the savings that result from having the CE build levees, install water control structures, and provide other assistance with making the site ready. Depreciation costs are normally calculated in several ways depending upon the nature of the depreciable item. For simplicity, this worksheet treats all depreciation the same (that is, levee improvements are the same as vehicles), ignores salvage value, and results in an annual cost-recovery figure that is an average based on a single number of years of amortization. It should be noted, based on the experience of the CAAP demonstration project, that depreciation should be accelerated because of the high probability that a DMCA is in a remote and relatively harsh environment.

ANNUAL SALES SUMMARY

SPECIES: Species

UNIT: Units

HARVEST 1

TOTAL UNITS HARVESTED		<--Insert
PRICE PER UNIT		<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES		<--Insert
UNITS HARVESTED / PER ACRE	NA	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	NA	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED		<--Insert
PRICE PER UNIT		<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES		<--Insert
UNITS HARVESTED / PER ACRE	NA	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	NA	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$0	(Harvests 1 & 2)

Figure 1. (Sheet 5 of 6)

The Annual Sales Summary worksheet makes straightforward calculations of harvest. It allows for two crops in a year which is feasible for shrimp.

Species ANNUAL INCOME STATEMENT

	With USCOE		W/out USCOE	
REVENUE				
Total Annual Sales		$0		$0
EXPENSES				
A. Total Variable Costs (Pg. 3)	$0		$0	
B. Total Fixed Costs (Pg. 4)	NA		NA	
Total Expenses with USCOE		NA		NA
C. USCOE FIXED COST SAVINGS (Pg. 4)			NA	
Total Expenses w/out USCOE				NA
NET INCOME		(a) NA		(b) NA

ANNUAL CASH BALANCE STATEMENT

	With USCOE		W/out USCOE	
NET INCOME		NA		NA
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	NA		NA	
Investment Loan Payment (Pg. 4, G)	NA		NA	
Total Loan Principals		NA		NA
USCOE'S Investment Loan Payments (Pg. 4, EE) turist's Fixed Costs Savings)				NA
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	NA		NA	
USCOE Investment (Savings) (Pg. 4, CC)	$0		NA	
Total Depreciation		NA		NA
CASH BALANCE (Net Income - Principals + Depreciation)		(c) NA		(d) NA

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	NA	(a) - (b)
ANNUAL CASH BALANCE DIFFERENCE	NA	(c) - (d)

Figure 1. (Sheet 6 of 6)

The final worksheet provides two forms of financial summary: an Annual Income Statement and an Annual Cash Balance Statement. The former considers the depreciation of capital investment expenses as an expense (as a fixed cost). This figure is added when considering the cash balance which reflects the actual flow of cash. In an income statement, the repayment of loan principals is not reflected whereas in a cash balance statement, this outlay of cash is shown. The payment of loan principals is calculated in the same manner as was depreciation. In the early years of loan repayment, there is a greater percentage of interest payment and less principal payment. For simplicity of calculation, the computer model treats repayment of principal as an average yearly outlay. The final calculation of the model is the value of having the CE build levees, install control structures, perhaps put in an access road, and contribute such preconstruction costs as chemical testing of sediments, assistance with permits, and other site evaluation costs that, though difficult to quantify, nevertheless would have to be borne by an aquaculturist beginning a business without the CE.

5 Economic Potential of Selected Species

Introduction

With the results of the demonstration project available for guidance, the DMCA aquaculture computer model was developed to allow an assessment of the economic potential of different species. The model worksheets described in the previous section can be used with data for virtually any species and can assist the potential aquaculturist in assessing the economics of any size DMCA operation.

Four evaluations were conducted as part of this research: catfish, crawfish, hybrid striped bass, and clams/oysters. Each of the target animals was examined for three scenarios: "low/break-even," "average," and "good." Crop values and harvest figures were taken from aquaculture literature to use in the worksheets to create the "average" scenario. The "low/break even" and "good" scenarios could have been created by adjusting any number of input figures. However, to keep the scenarios comparable, only the market price per pound (or other unit of sale) or the yield per acre for a given species was adjusted. Copies of the spreadsheets for each species are found in the appendix. Because all of the "average" scenarios resulted in positive net incomes and cash balances, "good" scenarios were not considered particularly useful for inclusion in this report. Instead two "low/break-even" scenarios were created. For the "average" scenario, all six spreadsheets were used to calculate the net income and cash balance. For the "break-even" scenarios, it was necessary to use only pg 5 - Annual Sales Summary - on which either the total harvest or the price per unit was adjusted, and pg 6 - Annual Income Statement and Annual Cash Balance Statement - on which the results of those adjustments were displayed.

The analyses examine hypothetical facilities that cover a range of DMCA sizes, but all are considered to be on a scale that can be managed by an owner/operator with part-time hired labor. All returns are to the owner/operator whose salary has not been included as a project expense. Yields for the "average" scenarios were somewhat below those that could be harvested to reflect the uncertainty of performance and management at a DMCA. The

prices for harvested products reflect average to below-average levels to account for potentially higher transportation costs. The remoteness of containment sites and possible additional costs necessary to transport products to markets or processors warranted the lower costs.

The evaluation species were chosen because they represent a broad range of cultured animals. Catfish are perhaps the most commonly grown fish crop both in regional extent and dollar value. Hybrid striped bass is another finfish, but is a species not yet widely cultured. It is expected to become a popular table item and may be well suited to DMCA's. Crawfish were evaluated because crawfish farming is not capital intensive and is a common income-supplementing crop. Crawfish are grown in many states and have broad potential. Finally, oysters and clams were evaluated together because mollusks are sessile organisms that require little management. They may be well suited for growth in small DMCA's on the crowded eastern seaboard.

Catfish

The commercial culture of freshwater catfish occurs in approximately 15 states. These include coastal states and inland states with numerous navigation systems requiring dredging. Freshwater catfish are a versatile species and have become the top finfish crop among domestic farmers. In 1990, approximately 350,000,000 lb were produced and marketed. Farms range from small, single-pond, fee-fishing businesses to corporately owned, multipond systems of 1,000 acres or more. While there are some businesses endeavoring to grow catfish in tanks and raceways, over 90 percent of catfish will continue to be produced in ponds.

Capital investment levels for catfish farms range from $1,500 to $2,500 per acre which does not include the cost of land purchase. Land suitable for catfish farming in the major producing areas such as Mississippi could range from $800 to $1,500 per acre. Use of containment sites could save this amount of investment capital. The other capital investment requirements for catfish farming include levees, wells, vehicles, aerators, buildings, and miscellaneous equipment. Essentially all commercial catfish operations use subsurface water. Drilling large, deep wells at a DMCA may not be practical or necessary because catfish production in DMCA's would likely use surface water. A DMCA catfish farm would have lower capital investment requirements without wells, and pumps for surface water use are less costly than pumps used for deep wells. The large amount of earth moving required to make levees for catfish farming also represents a considerable capital investment. Landowners in catfish producing areas of Louisiana and Mississippi are developing pond systems for $250 to $300 per acre.

Pond sizes in the delta areas of Mississippi and Louisiana are trending downward. As stocking levels increase and management intensifies, there is the need for more aeration, medication, and careful attention. Many catfish ponds are in the 10- to 15-acre size range, which indicates that smaller

DMCA's can be suitable for catfish production. The practice of filling ponds and replacing water as needed rather than draining to achieve a harvest decreases the need for large drainage structures. One aspect of containment sites is the occasional need for receiving dredged material. Catfish ponds in practice are normally taken out of production every 4 to 6 years for pond bottom and levee improvements. Coordinating this with the dredging cycle may be possible.

Operating costs should be similar between conventional sites and containment sites. The cost of power to operate pumps and aerators may be higher if a containment site is isolated. However, this cost may not be necessary because many catfish farmers invest in generator sets to produce their electricity on site.

Marketing costs could be higher at a containment site. This would consist of the harvest and hauling cost to a processing plant. The preferred and common means of marketing catfish begins with the delivery of live fish to the processing plants. In those instances where sites are isolated from efficient, reliable live-harvest and hauling companies, a DMCA catfish farmer could experience higher costs.

The CAAP spreadsheet program was used to evaluate a system of four 20-acre ponds. Total construction costs were estimated to be $102,453. This amount included costs of levees, water control structures, access roads, and preconstruction costs such as permitting and sediment testing. Of the total, $86,453 was identified as the USACE contribution. The aquaculturist's construction cost amounted to $16,000. An additional investment of $67,725 for equipment was necessary. The growth of catfish to market size of approximately 1.25 lb was assumed to have occurred within the year. The catfish harvest of 280,000 lb equates to 3,500 lb per acre and gross sales at $0.75 per pound amounted to $210,000. A net income estimate of $30,000 resulted after deducting total expenses of approximately $180,000. The break-even yield per acre was approximately 3,000 lb. If the fish price were to decrease to $0.65 per pound, the harvest per acre would have to be 3,462 lb per acre to break even. Thus, the original assumption of a 3,500-lb per acre yield actually turns out to be the break-even yield. The price range of $0.65 to $0.75 per pound covers the recent historical range for catfish farming. However, in 1990, a bargaining association maintained a delivered price of $0.80.

As previously indicated, the analysis was conducted as if an owner/operator controlled the farm. This is the reason that no expenditures for salaried employees such as a manager were included. The net income from the estimating procedure is reflective of returns to an owner/operator's equity, management, and labor contribution to the business. A defensible estimate of salaried management expense is $31,250. It includes a manager's base salary of $25,000 plus an additional 25 percent for payroll taxes and fringe benefits. Net income and cash balance estimates would be reduced by this expense in the event that the operator salary was paid.

The net income estimate accounts for the savings arising from CE participation which amounts to $27,017 annually in this scenario. The annual impact on the cash balance was estimated to be $16,210. The improved annual net income and cash balance make DMCA catfish culture feasible in this case even though both the yield of 3,500 lb per acre and the sale price of $0.75 per pound are below the industry average.

Crawfish

The commercial culture of red swamp crawfish (*Procambarus clarkii*) occurs in approximately nine states. Many other crawfish species are available in the United States on which to develop other aquaculture businesses in the future. The demonstrated adaptability of the red swamp crawfish to conditions from Maryland to Texas will make it the primary crawfish species for consideration in containment area business development. Aquaculturists in 1990 were estimated to have produced 80,000,000 lb from what are well-established, feasible sites. Farms range from single-pond, income-supplementing operations of 10 acres to large operations of more than 1,000 acres. This range of pond and business sizes indicates that crawfish are a suitable species to the diverse DMCA sites available.

Crawfish farming technology is completely pond-based. Intensive culture such as tank or tray water reuse systems are not cost competitive. Thus, for DMCA crawfish culture to be feasible, it must be competitive with pond-culture businesses. A description of the capital investment, operating cost, and marketing aspects of the conventional culture businesses will identify possible differences for the DMCA crawfish grower.

A crawfish farm of 40 acres can serve as the basis for description of investment requirements. The cost of land is, of course, widely variable. In Louisiana there are 125,000 acres devoted to crawfish farming. Land ranges from $800 to $1,500 per acre. Farmers using rented land typically pay on the basis of 20 percent of gross revenue. Levees are minimal in comparison to most other aquaculture operations. Levee height need not exceed 3 ft. A water depth of 18 to 24 in. is normal.

A means of pumping surface water is necessary. Water recommendations for crawfish include pumping at the rate of 100 gal per minute per acre. A surface agitating aerator is also recommended. A harvest boat, referred to as a crawfish combine, is essential. Crawfish harvesting occurs in the range of 100 to 150 days per year. Baited traps are used in harvesting. The number of traps varies by site but 20 per acre can be considered an average.

Investment at a DMCA would be lower than for a conventional operation due primarily to savings in land cost and levee construction. Operating costs should be similar between the two types of sites. Bait, fuel, and labor involved in harvesting can be up to 70 percent of operating costs. A possible difference in operating costs difference is the vegetation used by the crawfish

as a food source. Containment areas likely do not have the desired aquatic vegetation. Various preferred rice varieties can be established by annual planting. Though this is done on many crawfish farms that do not have the desired aquatic vegetation, the cost of planting rice is not necessarily an additional cost of operating at a DMCA.

Marketing costs consist primarily of grading, sacking, and transporting. These should be no different at a containment site. Location of DMCA's closer to cities because of ports and harbors may facilitate direct marketing. Slightly lower transportation costs and the advantage of higher sales prices are possible unique aspects of DMCA crawfish farming.

The CAAP spreadsheet program was used to evaluate a two-pond system of approximately 40 acres. Total construction costs were estimated to be \$18,504. This amount includes levees, water control structures, and preconstruction costs such as permitting and sediment testing The USACE contribution amounted to \$17,204 and the aquaculturist's construction cost amounted to \$1,300. An additional investment of \$25,200 for equipment was necessary. The crawfish harvest was estimated to be 40,000 lb or 1,000 lb per acre. At the crawfish price of \$0.60 per pound, the break-even yield per acre is slightly above 800 lb. If crawfish prices were to decrease to \$0.49 per pound, the 40,000-lb harvest would only produce sales to cover expenses. Prices above this \$0.49 level are conservative for areas outside of the major producing state of Louisiana. Since crawfish are harvested from 50 to 150 days per year, the higher prices encourage the intensification of harvesting effort. This in turn could offset the effects of some decrease in average yield if a DMCA is not ideally suited for crawfish production.

As previously indicated, the analysis was conducted as if an owner/operator controlled the farm. This is the reason that no expenditures were included for salaried employees such as a manager. The net income from sales is a return to the owner/operator's equity, management, and labor contribution to the business. Crawfish farming operations of this size would require approximately 6 hours daily for harvest and management activities to be completed. At the rate of \$15 per hour, the annual management expense for 80 days inclusive of payroll taxes and fringe benefits would be \$9,000. The net income estimate for an owner/operator was \$4,574 for the "average" case. This places the owner/operator at an effective hourly rate of \$7.50. For many prospective crawfish farmers seeking to supplement income, this wage could be an inducement.

The value of the USACE involvement saves the crawfish farmer approximately \$4,700 annually. This savings could make crawfish farming financially feasible. The impact on the cash balance was estimated to be approximately \$3,000. This amounted to about one-half of the \$6,639 cash balance position of the crawfish farm. Thus, USACE participation with the crawfish farmer essentially doubled the net cash balance.

Mollusks

New technologies to enhance the farming of mollusks, particularly hard clams and oysters, have stimulated investor interest. The continued stress placed on coastal waters from pollutants is one reason new technologies are being considered. Discharge of treated sewage, untreated stormwater runoff, industrial discharges, and erosion of wetlands combine to reduce the amount of quality growing areas. Fluctuations in water quality cause periodic closures of harvest grounds. Consequently, the supply of mollusks has become unreliable. This now occurs at a time when record seafood consumption levels are being reported. The situation with the eastern oyster (*Crassostrea virginica*) is particularly noteworthy. The combined effects of disease and habitat declines in the Chesapeake Bay led to a 65-percent decrease in production between 1985 and 1990. Eastern oyster production in 1990 was 22,000,000 lb below the 1980-85 average. Gulf of Mexico production has not shown either an upward or downward trend recently. In the Pacific northwest, hatcheries are producing spat to use in the remote setting of oysters. While the west coast oyster (*Crassostrea gigas*) would be considered an exotic on the east and Gulf coasts, this new technology is being applied to eastern oysters in the Gulf states. The possibility exists to apply hatchery and oyster-setting technology more widely and test the grow-out of oysters at a DMCA.

The market prospects for sale of the oysters is exceptionally good. There does not appear to be much reason for optimism for the natural fisheries to rebound and overcome the 22,000,000-lb shortfall. In response to the market shortage, prices for oysters received by producers more than doubled between 1983 and 1989. Production of more oysters from aquaculture would simply contribute to the restoration of some of the former supply. New markets need not be sought nor is competition from cheaper imports likely to occur. Half-shell or shucked oysters have little competition from foreign supply.

The situation and outlook for hard clam production is more optimistic compared to eastern oysters. Hard clams (*Mercenaria*) are becoming a focus of heightened research and commercial development. The high price paid for clams and the wide consuming area make the hard clam a good candidate for investment. Hatchery techniques reliably produce seed clams for stocking. Large quantities of seed can be produced at relatively low cost. An impediment has been labor in the culture process and the prevention or minimization of mortality due to predators. If aquaculture can reduce the dependence on natural systems for spawning and seed production and can reduce losses to predators, then commercial successes will increase.

Hard clam production in the United States has not been an expanding industry in terms of supply. During the 1980's, hard clam landings fluctuated between 9 and 18,000,000 lb of meat. The average annual landing for the decade was 13.5 million pounds of meat. The average for 1985 through 89 was 12.3 million pounds. This was notably lower than the 14.7-million-pound average of 1980 through 1984. The decrease in supply identifies a market shortage that aquaculture could fill. Clam prices received by producers

increased more than 50 percent from 1983 to 1989. While less than the price increase for oysters, clam prices increased faster than the inflation rate for the period. This increase in real prices is part of the stimulus for increased investment in hard clam aquaculture. A large part of the new investor interest can be attributed to the emergence of new technology. Besides hatcheries producing seed clams, advances have been made in alternative means by which to combine nursery stocks and operations for growout to market size. Growout to preferred market size can take place by use of intertidal pens, subtidal soft bags, or subtidal beds. Each of these systems had a positive cash flow when analyzed on the basis of financial criteria (Adams and Pomeroy 1990).

Use of a DMCA to culture mollusks commercially must be subjected to more rigorous evaluation than other species. The positive financial results of the hard clam analyses were for traditional growing areas. Such areas are selected for good water flow because of the filter-feeding nature of mollusks. Containment areas are not designed to allow tidal exchange routinely or occasionally. Thus, it would be important for prospective clam/oyster culturists to consult with biologists and USACE personnel regarding changes necessary to make a DMCA productive.

It should be noted that 2 to 3 years are required for growth to commercial size. During this period protection from boat traffic, poaching, and predators is critical. DMCA culture of hard clams may eliminate the need for predator control if water filtration is used when the pond is filled. Such costly investments as harvest bags or pens may not be necessary.

The CAAP spreadsheet program was used to evaluate a single pond of approximately 40 acres for the culture of hard clams. There are several technologies for growing clams such as the use of wire baskets, soft mesh bags, trays, or pens for use in subtidal waters. For a DMCA that could have a soft sediment layer on the bottom, soft mesh bags were chosen as a culture technique for analysis. It is recognized that this is an emerging technology. Total construction costs were estimated to be $27,504. This amount includes levees, water control structures, and preconstruction costs such as permitting and chemical analyses of sediments and water. The USACE contribution was estimated to be $23,704 and the aquaculturist's construction cost amounted to $3,800. An additional investment of $41,700 for equipment was necessary. Harvest in year 2 was estimated to be 1,000,000 clams. At the clam price of $0.17 each, the break-even yield would be approximately 550,000 clams. The assumed price is below recent historical levels to reflect a price net of transportation cost. Containment sites are likely to be more remote and the need to deliver clams to market alive could combine to increase marketing/transporting costs above average.

As previously indicated, the analysis was conducted as if an owner/operator controlled the clam farm. This is the reason that no expenditures for salaried employees such as a manager were included. The net income from sales is a return to an owner/operator's equity, management, and labor contribution to the business. The clam farm analysis already includes substantial hired labor

expenses because the clam farm needs a more highly skilled person routinely on site. The owner/operator's contribution to the clam farm was estimated at $37,500 annually inclusive of payroll taxes and fringe benefits. Net income and cash balance estimates would be lower by twice this amount to account for the 2-year management expense. The net income estimate includes the approximately $12,000 of savings arising from USACE participation over the 2-year crop cycle. The impact on the cash balance annually was estimated to be approximately $2,600 for a cycle savings of $5,200.

Hybrid Striped Bass

The commercial-scale culture of hybrid striped bass (HSB) in the United States began in the latter 6 months of the 1980's. They are being farmed in such diverse locations as semiarid sections of the southwest, the deep south, and the mid-Atlantic states. Several technologies are used. Companies in the southwest generally use intensive management. This includes geothermal-heated fresh water used in circular tanks to grow HSB at high densities. Companies in the deep south and mid-Atlantic states more commonly use conventional ponds. However, some tank culture operations do exist.

Since DMCA's occur in a range of sizes and locations, they are suitable for culture of HSB given the characteristics of existing culture operations. Ponds used for conventional HSB culture tend to be smaller than other finfish ponds. Most finfish pond experience in the United States is related to catfish. Literature on catfish pond production commonly refers to ponds of 15 to 20 acres. HSB ponds have, at this early stage of the industry, been 3 to 10 acres. This is advisable strategy in the early stages of this species' adaption to pond culture. Many DMCA's are small enough to fit this pattern or are large enough for interior levees to be established.

Containment sites also are located in widely ranging salinities. Most HSB operations use fresh water even though brackish water culture is possible. Thus, containment sites in freshwater areas may be the first to be attempted. Wells are usually the source of the fresh water in pond operations. To benefit from participation with the USACE, a DMCA aquaculturist may forego making a significant capital improvement to the site such as a freshwater well. Capital-use efficiency would be improved if well costs were not incurred. The combined capital expense savings on the levee, well, etc. is a benefit of DMCA use. Surface water would have to be used with caution with all containment area sites. A DMCA site manager would have to develop and operate a reliable screening process to remove predator and nuisance species from entry to a pond where HSB were being raised.

The technology for HSB pond operations appears to require holding the fish into a second year. Raising HSB may therefore require ponds that can accommodate a reduction in fish density per acre. As fish grow to a larger size, their density will have to be reduced by transfer of some number to adjacent ponds or cells. The DMCA aquaculturist will have to allow for this and have more

than one pond or cell. An alternative, given one pond, is to stock the fish at low enough density to account for the desired biomass density in 2 years.

The capital investment savings related to levees, land leveling, water control structures, wells, permits, etc. related to DMCA aquaculture are significant. A caution is necessary in regard to HSB due to the current management approach of a two-pond system. The number of containment sites with two disposal ponds or the cost of adding a levee to a single pond site will change the financial situation.

The CAAP worksheet program was used to evaluate a two-pond system of approximately 40 acres. Total construction costs were estimated to be $65,882. This amount includes levees, water control structures, access roads, and preconstruction costs such as permitting and sediment testing. The USACE contribution was estimated to be $54,882, and the aquaculturist's construction cost amounted to $11,000. An additional investment of $47,600 for equipment was necessary. HSB harvest in year 2 was estimated to be 145,800 lb or 3,645 lb per acre. This combination produced a large net income reflective of the high investor interest in HSB aquaculture. At the fish price of $2.50 per pound, the break-even yield per acre is slightly below 2,000 lb. If fish prices were to decrease to $1.00 per pound, the harvest per acre would be 4,700 lb for break even to occur. This level of harvest is unlikely given HSB technology in such large ponds.

As previously indicated, the analysis was conducted as if an owner/operator controlled the farm. This is the reason that no expenditures for salaried employees such as a manager were included. The net income from sales is a return to an owner/operator's equity, management, and labor contribution to the business. An estimate of salaried management expense is $37,500 annually, inclusive of payroll taxes and fringe benefits. Net income and cash balance estimates would be lower by twice this amount to account for the expense of 2 years of management. The net income estimate accounts for the savings arising from USACE participation. The value of USACE participation saves the aquaculturist approximately $17,000 annually. This improves the net income significantly. The impact on the annual cash balance was estimated to be approximately $10,000. For the 2-year production cycle, the net income statement reflects about a $34,000 increase with USACE participation for the first harvest. The corresponding estimate of net cash balance after harvest is $20,000 higher with USACE participation.

6 Literature Summary and Information Sources

Introduction

In addressing the economics and marketing of DMCA aquaculture, several general and technical fields were reviewed for pertinent literature and guidance. These fields include the CAAP, DMCA aquaculture, aquaculture business planning and economics, and the culture of shrimp, catfish, crawfish, hybrid striped bass, clams, and oysters. Data sources that have been cited or used in preparation of this report are listed in this section by topic. They are preceded by a description of sources that can be consulted for either additional or more current information.

Sources of additional information are categorized as:

a. Regulatory/policy.

b. Technical.

c. Periodicals.

The international nature of aquaculture and frequent domestic industry changes can make lists of information sources quickly outdated. Addresses may change, but agency and publication names identified in the following list should remain reliable. Listed with each source is a description of the types of information available.

Regulatory and Policy Agencies

Local

a. Zoning commission: permits, variances.

b. Environmental: potential water discharge permit comments, solid waste disposal permit comments.

State

a. Fisheries department: permits to raise exotic species, inspection for disease presence in fingerlings and imported broodstock, procedures for harvesting broodstock, transporting/marketing product, wetlands permit comments.

b. Natural resources/environmental quality department: wetlands permit, water use permit, water discharge structure design and permit, regulation of residual chemicals in soil.

c. Agriculture department: potential source of limited financial inducements.

d. Coastal zone management office: permit to build consistent with state's coastal management plan, comment on other agency permits, possible design constraints.

Federal

a. U.S. Army Corps of Engineers: permit to construct in wetland, containment area availability, design recommendations for containment area aquaculture, permit for structure in navigable waterway.

b. U.S. Environmental Protection Agency: water discharge permit, wastewater treatment review, pesticide registration, and research and development.

c. U.S. Fish and Wildlife Service (U.S. Department of Interior): permit comments regarding habitat; excellent background in fish hatchery systems, water use procedures, fish health.

d. National Marine Fisheries Service (U.S. Department of Commerce): permit comments; role in importation of exotic species, harvest of broodstock; expertise in culture of marine species; source of international information on culture industries; statistical reports on fisheries, landings, and seafood consumption in the United States.

e. Department of Agriculture: primary funding agency for aquaculture research and information extension programs, regular publisher aquaculture situation and outlook report, source of construction and operating loan financing through the Farmers Home Administration.

f. Soil Conservation Service (U.S. Department of Agriculture): soil mapping information for use in complying with permits, levee, and water structure design assistance from engineering staff.

g. U.S. Food and Drug Administration: potential role in approval of medications to treat diseases, monitoring of chemicals in product.

Technical

Cooperative extension services

This source of technical information is Federal, State, and locally funded. Each county has an Extension Service office often listed in the white pages of the telephone book. The Land Grant University in each state has Extension Service specialists located at the University. Biological, veterinary, economics, engineering, and other specialists are available to answer information requests. This is an excellent source of publications, newsletters, conferences, and videotapes.

Agricultural experiment stations

Each Land Grant University conducts research at experiment stations and in academic departments. Individual researchers may be able to provide "in-process" insight to specific projects. Relevant academic departments and projects can be identified by the university's director of the Agricultural Experiment Stations. Larger universities may have a coordinator of aquaculture programs.

Regional aquaculture centers

A cooperative effort of the U.S. Department of Agriculture and universities has resulted in the formation of regional aquaculture centers. These are centers that fund research and extension programs at cooperating universities. Most information available from a center's office will reflect information generated by universities. The five regional aquaculture centers are:

a. Northeastern Regional Aquaculture Center
Southeastern Massachusetts University
North Dartmouth, MA 02747
(508)999-8157

b. Western Regional Aquaculture Center
School of Fisheries
College of Ocean and Fishery Sciences
University of Washington
Seattle, WA 98195
(206)543-4290

c. Center for Tropical & Subtropical Aquaculture
The Oceanic Institute
Makapuu Point
Maimanalo, HI 96795
(808)259-7951

d. North Central States Regional Aquaculture Center
Fisheries & Wildlife Department
13 Natural Resources Bldg.
Michigan State University
East Lansing, MI 48824
(517)353-1962

e. Southern Regional Aquaculture Center
Delta Branch Experiment Station
P. O. Box 197
Stoneville, MS 38776
(601)686-9311

National Aquaculture Information Center

Both practical and technical reference support is available. International literature is indexed and abstracted in a database called Aquatic Sciences and Fisheries Abstracts. *Aquaculture: A Guide to Federal Government Programs*, a 1987 publication identifying Federal programs, is available from the Aquaculture Information Center. The Center is part of the U.S. Department of Agriculture's National Agriculture Library. Most of the services are free. It is located in Beltsville, MD.

Aquaculture Information Center
U.S. Department of Agriculture
10301 Baltimore Boulevard, Room 304
Beltsville, MD 20705-2351
(301) 344-3704

Periodicals

There are many regularly published sources of information. Those listed below include magazines, journals, and newsletters. Due to the rapidly evolving aquaculture industry, no list can be considered complete. Cooperative Extension Service personnel should be able to assist in procuring newly developed periodicals.

Aquaculture Digest
9434 Kearny Mesa Road
San Diego, CA 92126

This is a monthly report on marine fish and shellfish farming. It is available by subscription.

Aquaculture Magazine
P. O. Box 2329
Asheville, NC 28802

This a a bimonthly magazine of freshwater and marine aquaculture developments. It is available by subscription.

Aquafarm Letter
Box 14260
Benjamin Franklin Station
Washington, DC 20044

This is a timely newsletter that covers regulatory and policy matters primarily focused on Washington, DC. It is available by subscription.

Catfish News/Aquaculture News
Aquacom, Inc.
P. O. Box 4566
Jackson, MS 39296

This is a monthly publication covering aquaculture with emphasis on catfish but inclusive of most domestic freshwater development. It is available by subscription.

Fish Farmer
34 Amberly Drive
Woodham
Weybridge
Surrey, KT 153SL
England

This is an international magazine. The "International File" supplement covers information on marketing, financial planning and technology.

Fishery Market News Report
National Marine Fisheries Service
World Trade Center
2 Canal Street, Suite 400-H
New Orleans, LA 70130-1206

This is a source of varied information on natural fisheries. It includes a monthly summary of marketing and price data on farm raised catfish. It is available by subscription.

Fisheries of the United States
Superintendent of Documents
Government Printing Office
Washington, DC 20402

This is an annual report inclusive of production, import, export, consumption, and price statistics. It is prepared by the National Marine Fisheries Service.

INFOFISH
P. O. Box 10899
Kuala Lumpur, Malaysia 50728

This is a bimonthly publication inclusive of articles on overseas aquaculture and market development. It is available by subscription.

Journal of the World Aquaculture Society
World Aquaculture Society
Room 143, J.M. Parker Coliseum
Louisiana State University
Baton Rouge, LA 70803

This is a professional journal including scientific articles on all aspects of fish farming. It is available by subscription.

Salmonid Magazine
506 Ferry St.
Little Rock, AR 72202

This is a trade magazine with information and articles on the trout and salmon industries. It is published quarterly and is free to members of the U.S. Trout Farming Association.

Shrimp Notes
Shrimp World, Inc.
417 Eliza Street
New Orleans, LA 70114

This is a specialized newsletter that is a market news analysis covering domestic and international shrimp supply and marketing developments. It is available by subscription.

Water Farming Journal
3400 Neyrey Dr.
Metairie, LA 70002

This is a newspaper on current events in the aquaculture industry.

References

Adams, C., and Pomeroy, R. (1990). "Preliminary financial feasibility analysis for hard clam mariculture systems," Staff Paper 381, Food and Resource Economics Department, University of Florida, Gainesville, FL.

Hollin, D., and Griffin, W. L. (1985). "Preliminary economics of shrimp mariculture in Texas." *Texas Shrimp Farming Workshop*. George Chamberlain, Michael Haby, Russell Miget, ed., Texas Agricultural Extension Service, Corpus Christi, TX.

Keenum, M. E., and Waldrop, J. E. (1988). "Cash flow analysis of farm raised catfish production in Mississippi," Agricultural and Forestry Experiment Station Technical Publication No. 73, Mississippi State University, MS.

Lawrence, A. L., Johns, M. A., and Griffin, W. L. (1984). "Shrimp mariculture: state of the art," Sea Grant Publication TAMU-S6-84-502, Texas A & M University, College Station, TX.

Parker, J. C. (1988). "Shrimp farm investment analysis for outdoor ponds in Texas." Mariculture Consultant, Harlingen, TX.

Quick, J. S., Milligan, D. J., Hill, S. E., Hover, R. J., and McIlhenny, W. F. (1978). "Field demonstration shrimp mariculture in dredged material containment areas," Technical Report D-78-53, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Rosenberry, R. (1990). "World shrimp farming, can the western hemisphere compete with the eastern?" *Aquaculture Magazine* 16(5), 60-64.

Saucier, R. T., Calhoun, C. C., Jr., Engler, R., Patin, T. R., and Smith, H. K. (1978). "Executive overview and detailed summary," Technical Report DS-78-22, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Bibliography

DMCA Aquaculture

Coleman, R. E., Konikoff, M., and Dugger, D. "Containment area aquaculture pond operations" (technical report in preparation), U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Homziak, J., Hayes, D., and Veal, D. "Design and construction of aquaculture facilities in dredged material containment areas," (technical report in preparation), U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Homziak, J., and Lunz, J. D., ed. (1983). "Aquaculture in dredged material containment areas proceedings," Miscellaneous Paper D-83-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Lunz, J. D., and Konikoff, M. (1988). "Use of dredged material containment areas for aquaculture." *The Ecology and Management of Wetlands* 2.

Lunz, J. D., Nelson, D. A., and Tatem, H. E. (1984). "Aquaculture in dredged material containment areas." *Proceedings of the Conference Dredging '84*. Waterway, Port, Coastal and Ocean Division, American Society of Civil Engineers, 235-253.

Quick, J. S., Milligan, D. J., Hill, S. E., Hover, R. J., and McIlhenny, W. F. (1978). "Field demonstration of shrimp mariculture in dredged material containment areas," Technical Report D-78-53, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Robertshaw, S., McLaughlin, R., and Love, D. (1993). "Legal and institutional constraints on aquaculture in dredged material containment areas," Technical Report EL-93-7, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Saucier, R. T., Calhoun, C. C., Jr., Engler, R., Patin, T. R., and Smith, H. K. (1978). "Executive overview and detailed summary," Technical Report DS-78-22, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Tatem, H. E. (1988). "Determination of the chemical suitability of a dredged ma:_rial containment area for aquaculture," Technical Report EL-90-12, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Wilson, J., Homziak, J., and Coleman, R. E. "Site selection, aquisition, and planning for aquaculture in dredged material containment areas" (technical report in prepartion), U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Aquaculture Business Planning

Hanson, J. S., Griffin, W. L., Klinefelter, D. A., and Fisher, D. V. (1988). "Developing an aquaculture business proposal," Texas A&M Agricultural Experiment Station, College Station, TX.

Muir, J. (1988). "Aquaculture consultancy services - the realities," INFOFISH International, Kuala Lumpur, Malaysia.

Parker, N. C. (1989). "History, status, and future of aquaculture in the United States," *Aquatic Sciences Journal*, 1(1).

Roberts, K. J., and Harper, C. D. (1988). "Aquaculture investment analysis guide," Louisiana Agricultural Experiment Station, Louisiana Cooperative Extension Service, Baton Rouge, La.

Shrimp Culture

Adams, C. M., and Prochaska, F. "Principal economic factors determining U.S. shrimp prices at alternative market levels" (unpublished manuscript), Food and Resource Economics Department, University of Florida, Gainesville, FL.

Adams, C. M., Prochaska, F., and Spreen, T. H. (1987). "Price determination in the U.S. shrimp market," *Southern Journal of Agricultural Economics*, Clemson, SC.

Hollin, D., and Griffin, W. L. (1985). "Preliminary economics of shrimp mariculture in Texas," *Texas Shrimp Farming Workshop*, George Chamberlain, Michael Haby, Russell Miget, ed., Texas Agricultural Extension Service, Corpus Christi, TX.

Johns, M., Griffin, W., Lawrence, A. L., and Fox, J. (1981). "Budget analysis of penaeid shrimp hatchery facilities," *Journal of the World Mariculture Society* 12(2).

Lawrence, A. L., Johns, M. A., and Griffin, W. L. (1984). "Shrimp mariculture: state of the art," Sea Grant Publication TAMU-S6-84-502, Texas A & M University, College Station, TX.

Pardy, C. R., Griffin, W. L., Johns, M. A., and Lawrence, A. L. (1983). "A preliminary economic analysis of stocking strategies for penaeid shrimp culture," *World Mariculture Society*, 14.

Parker, J. C. (1988). "Shrimp farm investment analysis for outdoor ponds in Texas," Mariculture Consultant, Harlingen, TX.

Parker, J. C., and Hayenga, W. (1979). "An analysis of the investment considerations for penaeid shrimp mariculture in pond systems," Texas A&M University, College Station, TX.

Pawlyk, P. W., and Roberts, K. J. (1984). "Forecasting U.S. shrimp prices: A comparison of three different models" (unpublished manuscript), Center for Wetland Resources, Louisiana State University, Baton Rouge, LA.

Pruder, G., Wyban, J., and Ogle, J. (1985). "U.S. marine shrimp farming industry: current status of domestic producers," Gulf Coast Research Laboratory Consortium, Oceanic Institute, Tufts University, Medford, MA.

Rhodes, R. J., Sandifer, P. A., Hopkins, S., and Whetstone, J. M. (1987). "Financial analysis of semi-intensive penaeid shrimp farming in South Carolina: April, 1987 update," South Carolina Marine Resources Center, Charleston, SC.

Rhodes, R. J., Sandifer, P. A., and Whetstone, J. M. (1987). "A preliminary financial analysis of semi-intensive penaeid shrimp farming in South Carolina," Technical Report No. 64, South Carolina Marine Resources Center, Charleston, SC.

Roberts, K. J., and Pawlyk, P. W. (1984). "The U.S. market - looking forward toward 1990," *Proceedings of Shrimp World One*, Shrimp World, Inc., New Orleans, LA.

Rosenberry, R. (1990 (Sep - Oct)). "World shrimp farming, can the western hemisphere compete with the eastern?" *Aquaculture Magazine*, 16(5), 60-64.

Catfish Culture

Aquaculture Task Force. (1987). "Catfish aquaculture: A decision-making guidebook," Louisiana Cooperative Extension Service, Baton Rouge, LA.

Crews, J., and Jensen, J. W. (1989). "Budget and sensitivity analyses for Alabama catfish production," Alabama Cooperative Extension Service, Auburn, AL.

Dellenbarger, L. E., Vandeveer, L. R., and Lavergne, D. (1987). "The economics of catfish production." *Proceedings of the Louisiana Aquaculture Conference 1987.* R. C. Reigh, ed., Louisiana State University Agricultural Center, Baton Rouge, LA.

Hatch, V., Denham, R., Hebicha, H., and Jensen, J. (1987). "Economic analysis of channel catfish egg, fry, fingerling, and food fish production in Alabama," Alabama Agricultural Experiment Station, Circular 291, Auburn, AL.

Keenum, M. E., and Waldrop, J. E. (1988). "Cash flow analysis of farm raised catfish production in Mississippi," Agricultural and Forestry Experiment Station Technical Publication No. 73. Mississippi State University, MS.

_________. (1988). "Economic analysis of farm-raised catfish production in Mississippi," Mississippi Agricultural and Forestry Experiment Station, Mississippi State University, MS.

Pennington, V. (1985). "Catfish production cost estimates for farms with level land," Arkansas Cooperative Extension Service, Pine Bluff, AR.

Pomeroy, R. S., and Luke, D. B. (1986). "Budgets and cash flow statements for South Carolina catfish production," South Carolina Agricultural Experiment Station, Clemson, SC.

Clam Culture

Adams, C., and Busby, D. (1989). "An economic overview of Florida hard clam production, value, and market channels," Department of Food and Resource Economics, University of Florida, Gainesville, FL.

Adams, C., and Pomeroy, R. (1990). "Preliminary financial feasibility analysis for hard clam mariculture systems, Staff Paper 381, Food and Resource Economics Department, University of Florida, Gainesville, FL.

de Franssu, L. (1990). "North American clam market," INFOFISH International, Kuala Lumpur, Malaysia.

_________. (1990). "The world market for bivalves," Globefish Research Program, Food and Agriculture Organization of the United Nations, New York.

Crawfish Culture

Brunson, M. W. (1989). "Double cropping crawfish with sorghum in Louisiana," Louisiana Agricultural Experiment Station, Baton Rouge, LA.

Dellenbarger, L. E., Vandever, I . R., and Clarke, T. M. (1987). "Estimated investment requirements, production costs, and breakeven prices for crawfish in Louisiana," D.A.E. Research Report No. 70, Louisiana Agricultural Experiment Station, Baton Rouge, LA.

Gabel, S. J., and Easley, J. E., Jr. (1989). "Costs of producing crawfish in North Carolina" (unpublished manuscript), North Carolina Cooperative Extension Service, Raleigh, NC.

Haby, M. G., and Younger, W. R. (1990). "Texas crawfish aquaculture," Texas Agricultural Experiment Station, College Station, TX.

LaCaze, C. (1981). "Crawfish farming," Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA.

Pomeroy, R. S., and Kahl, K. H. (1987). "Crawfish in South Carolina: development and current status of the industry," South Carolina Agricultural Experiment Station, Bulletin 661, Clemson, SC.

Roberts, K. J. (1984). "Financial information for crawfish farming," *Proceedings of the 1984 Louisiana Crawfish Farmers Association Annual Meeting.* Louisiana Cooperative Extension Service, Baton Rouge, LA.

Hybrid Striped Bass Culture

Brown, J. W., Easley, J. E., Jr., and Hodson, R. G. (1988). "Investment and production costs for the hybrid striped bass X white bass in North Carolina," UNC Sea Grant College Program, Raleigh, NC.

Harvey, P. A., Kirkley, J. E., Richardson, L. M., and Sanko, J. J. (1990). "Hybrid striped bass aquaculture survey and market potential," Dept. of Marine Advisory Services, Virginia Institute of Marine Science, Gloucester, VA.

Helfrich, L. A., Livey, G. S., and Neves, R. J. (1988). "Hybrid striped bass farming: a review of research and development opportunities," Research Series No. 2. Dept. of Fisheries and Wildlife Sciences, Virginia Tech University, Blacksburg, VA.

Hodson, R., Smith, R., McVey, J., Harrell, R., and Davis N. (1987). "Hybrid striped bass culture: status and perspective," University of North Carolina Sea Grant College, UNC-S6-87-03, Raleigh, NC.

Liao, D. S. (1987). "The economic and market potential for hybrid bass: a preliminary evaluation," *Journal of the World Aquaculture Society*, 16,151-157.

McCraren, J. P. (1989). *The Aquaculture of Striped Bass: A Proceedings.* Cooperative Extension Service, University of Maryland, UM-SG-MAP-84-01, College Park, MD.

Smith, T. I. J. (1988). "Aquaculture of striped bass and its hybrids in North America," *Aquaculture Magazine - January/February.*

__________. (1989). Semi-intensive pond production of market-size striped bass X white bass hybrids," *World Aquaculture*, 20(1).

__________. (1989). "Striped bass and its hybrids," *Journal of the World Aquaculture Society*, 20(1).

Appendix A
CAAP Economics and Marketing Worksheets

The User's Guide for the worksheet program is reproduced on the following page. It provides the step-by-step instructions for operating the program.

The appended worksheets which follow the User's Guide were used to evaluate the economic feasibility of selected species. Each species was analyzed with figures to produce an "average" scenario which was followed by two "break-even" scenarios. These were created by adjusting the yield and the price received per unit. Only pp 5 and 6 of the worksheet were changed to show the results of the break-even scenarios.

USER'S GUIDE

CONTAINMENT AREA AQUACULTURE PROGRAM
ECONOMICS AND MARKETING SPREADSHEETS

The Containment Area Aquaculture Program (CAAP) spreadsheets were designed to be used by Lotus 1-2-3, Version 2.2 with Allways (to print the reports). The Allways program is set up as Application 3 and is assigned to the key sequence <Alt> <F9> (press the <Alt> and <F9> keys simultaneously to activate it).

The spreadsheets are divided into five directories of the floppy disk as follows:

\	=> Blank CAAP spreadsheets (ready for data entry)
\CATFISH	=> Catfish example from manual
\CLAMS	=> Clams example from manual
\CRAWFISH	=> Crawfish example from manual
\HSB	=> Hybrid Striped Bass example from manual

To view the spreadsheets for a certain model, select /FD (File, Directory) from the Lotus menu, and enter the appropriate directory. For example, if your floppy disk is in Drive B: and you want to work with the Catfish model, type /FDB:CATFISH and press <Enter>. Next, retrieve (File, Retrieve) the main menu spreadsheet (DMCAMENU) from the model by pressing /FRDMCAMENU and pressing <Enter>. A menu for the different spreadsheets in the model will be presented at the top of the screen; highlight the appropriate spreadsheet and press <Enter>. For example, to view the Annual Variable Cost spreadsheet, highlight VARIABLE-COSTS by pressing the right arrow key twice followed by <Enter>.

Each of the six spreadsheets in the model will have several options displayed at the top of the screen when it is first retrieved. Typically, these will be EDIT, SAVE, PRINT, the next successive spreadsheet, and MAIN-MENU. For example, in the Annual Variable Costs spreadsheet, the menu will be:

EDIT	=>	Select this option to place you at the first "<-Insert" cell of the spreadsheet. After editing is complete, press <Alt>M and the menu will reappear.
SAVE	=>	Save the spreadsheet if any edits were made.
PRINT	=>	Print the spreadsheet using Allways (setup as APP3).
FIXED-COSTS	=>	Retrieve the Annual Fixed Cost spreadsheet (the next spreadsheet of the model). This option title will vary between spreadsheets.
MAIN-MENU	=>	Retrieve the Main Menu (DMCAMENU).

To select an option, highlight it with the arrow keys and press <Enter>.

If you have any questions concerning these models, please contact Dave Marschall or Alan Schuetz at C-K Associates, Inc., in Baton Rouge, Louisiana at (504) 755-1000.

Date

Species

CONSTRUCTION COSTS

DIRT VOLUME per LINEAR FOOT CALCULATION

A = TOP Width	______	Ft.	<-Insert
B = BASE Width	0	Ft.	B = (S1+S2) x H + A
H = HEIGHT	______	Ft.	<-Insert
S1 = INNER SLOPE	______	Ft.	<-Insert
S2 = OUTER SLOPE	______	Ft.	<-Insert

DIRT VOLUME AND COST CALCULATIONS

VOLUME = 0 CU. FT. per LINEAR FT. (A + B)/2 x H

LENGTH = ______ LINEAR FT. <-Insert

TOTAL VOLUME = 0 CU. YD. (VOLUME x LENGTH / 27)

DIRT MOVING COST: ______ PER CU. YD. <-Insert

USCOE'S CONSTRUCTION COSTS

A. LEVEE (Dirt Moving) COST	$0	(Dirt Moving Cost x Total Volume)
B. WATER CONTROL STRUCTURE(S)	______	<-Insert
C. ACCESS ROAD	______	<-Insert
D. PRECONSTRUCTION COSTS (permits, tests, etc.)	______	<-Insert
USCOE'S Total Construction Costs (A, B, C, D)		$0

AQUACULTURIST'S CONSTRUCTION COSTS

E: POND IMPROVEMENTS (seeding, shaping, etc.)	______	<-Insert
F. SITE IMPROVEMENTS & UTILITIES (piers, pilings, septic system, electricity, water, etc.)	______	<-Insert
G. PRECONSTRUCTION COSTS (permits, tests, etc.)	______	<-Insert
H. CONSTRUCTION SUPERVISION	______	<-Insert
Aquaculturist's Total Construction Costs (E, F, G, H)		$0
USCOE & AQUACULTURIST'S TOTAL CONSTRUCTION COSTS		$0

U.S. ARMY CORPS OF ENGINEERS
CONTAINMENT AREA AQUACULTURE PROGRAM
ECONOMICS AND MARKETING WORKSHEET

Date

Species

INITIAL INVESTMENT COSTS

EQUIPMENT COSTS

AERATOR & SCREEN	________	<— Insert
BOAT & MOTOR	________	<— Insert
BUILDING (Feed Storage)	________	<— Insert
BUILDING (Office/Service)	________	<— Insert
CHEMICALS	________	<— Insert
COOLERS	________	<— Insert
FEED BINS	________	<— Insert
FEEDERS	________	<— Insert
FLOATS	________	<— Insert
GENERATORS	________	<— Insert
HARVEST BASKETS	________	<— Insert
HARVEST MACHINE	________	<— Insert
MESH BAGS	________	<— Insert
MOWER	________	<— Insert
NETS	________	<— Insert
NIGHT LIGHTS	________	<— Insert
PUMP SHED	________	<— Insert
TRAILER	________	<— Insert
TRAPS	________	<— Insert
VALVES	________	<— Insert
VEHICLES	________	<— Insert
WATER PIPE	________	<— Insert
WELL & PUMPS	________	<— Insert
WET SUIT / SCUBA	________	<— Insert
OTHER: Miscellaneous	________	<— Insert
OTHER: ________	________	<— Insert
OTHER: ________	________	<— Insert
OTHER: ________	________	<— Insert
TOTAL EQUIPMENT COST	$0	

INITIAL INVESTMENT COSTS SUMMARY

Aquaculturist's Investment Costs			
Total Equipment Costs	$0		
Total Construction Costs (Page 1):	0		
Total Investment Costs		$0	
USCOE'S Investment Costs			
Total Construction Costs (Page 1)		$0	
Total Aquaculturist's & USCOE'S Initial Investment Costs			$0

U.S. ARMY CORPS OF ENGINEERS
CONTAINMENT AREA AQUACULTURE PROGRAM
ECONOMICS AND MARKETING WORKSHEET

Date

Species

ANNUAL VARIABLE COSTS

VARIABLE PRODUCTION COSTS

BAIT	______	<--Insert
CHEMICALS	______	<--Insert
FEED	______	<--Insert
FERTILIZER	______	<--Insert
FINGERLINGS / POSTLARVAE	______	<--Insert
FUEL	______	<--Insert
HARVESTING	______	<--Insert
HAULING	______	<--Insert
HIRED LABOR & PAYROLL TAX	______	<--Insert
ICE	______	<--Insert
MANAGER	______	<--Insert
PROCESSING	______	<--Insert
REPAIRS & MAINTENANCE	______	<--Insert
SACKS	______	<--Insert
SEED	______	<--Insert
SUPPLIES	______	<--Insert
TRANSPORTATION	______	<--Insert
UTILITIES (Electricity, Telephone, Etc.)	______	<--Insert
OTHER: ______	______	<--Insert
OTHER: ______	______	<--Insert
OTHER: ______	______	<--Insert
OTHER: ______	______	<--Insert
A. SUB-TOTAL VARIABLE COSTS	$0	

OPERATING LOAN COSTS

B. % of Variable Costs Borrowed	______	<--Insert
C. Total Amount of Operating Loan	$0	(A x B)
D. Term of Operating Loan (Years)	______	<--Insert
E. Annual Operating Loan Payment	NA	(C / D)
F. % of Interest on Operating Loan	______	<--Insert
G. Interest Paid on Operating Loan	$0	(C x F)
H. TOTAL VARIABLE COSTS	$0	(A + G)

Date

Species

ANNUAL FIXED COSTS

AQUACULTURIST'S EXPENDITURES / DEPRECIATION

A.	Total Investment Costs	$0	(From Page 2)
B.	Amortization Schedule (Years)		<--Insert
C.	Annual Investment Depreciation	NA	(A / B)
D.	% of Initial Investment Borrowed		<--Insert
E.	Amount of Investment Loan	$0	(A x D)
F.	Term of Loan (Years)		<--Insert
G.	Annual Principal Payment	NA	(E / F)
H.	% of Interest on Investment Loan		<--Insert
I.	Interest Paid on Investment Loan	$0	(E x H)
J.	Annual Insurance Premiums		<--Insert
K.	Salaried Employees and Payroll Taxes		<--Insert
L.	Miscellaneous		<--Insert
M.	Other ____________________		<--Insert
	TOTAL FIXED COSTS	NA	(C+I+J+K)

AQUACULTURIST'S FIXED COSTS SAVINGS

(Based on Value of USCOE'S Contribution to Total Construction Costs)

AA.	USCOE'S Total Construction Costs	$0	(From Page 1)
BB.	Amortization Schedule (Years)	0	(B above)
CC.	Annual Investment Depreciation	NA	(AA / BB)
DD.	% of Initial Investment Borrowed	0%	(D above)
EE.	Total Amount of Investment Loan	$0	(AA x DD)
FF.	Term of Loan (Years)	0	(F above)
GG.	Annual Principal Payment	NA	(EE / FF)
HH.	% of Interest on Investment Loan	0%	(H above)
II.	Interest Paid on Investment Loan	$0	(EE x HH)
	AQUACULTURIST'S FIXED COSTS SAVINGS	NA	(CC + II)

ANNUAL SALES SUMMARY

SPECIES: Species

UNIT: Units

HARVEST 1

TOTAL UNITS HARVESTED		<--Insert
PRICE PER UNIT		<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES		<--Insert
UNITS HARVESTED / PER ACRE	NA	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	NA	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED		<--Insert
PRICE PER UNIT		<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES		<--Insert
UNITS HARVESTED / PER ACRE	NA	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	NA	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$0	(Harvests 1 & 2)

Date

Species

ANNUAL INCOME STATEMENT

		With USCOE		W/out USCOE
REVENUE				
Total Annual Sales		$0		$0
EXPENSES				
A. Total Variable Costs (Pg. 3)	$0		$0	
B. Total Fixed Costs (Pg. 4)	NA		NA	
Total Expenses with USCOE		NA		NA
C. USCOE FIXED COST SAVINGS (Pg. 4)			NA	
Total Expenses w/out USCOE				NA
NET INCOME		(a) NA		(b) NA

ANNUAL CASH BALANCE STATEMENT

NET INCOME		NA		NA
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	NA		NA	
Investment Loan Payment (Pg. 4, G)	NA		NA	
Total Loan Principals		NA		NA
USCOE'S Investment Loan Payments (Pg. 4, EE) ulturist's Fixed Costs Savings)				NA
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	NA		NA	
USCOE Investment (Savings) (Pg. 4, CC)	$0		NA	
Total Depreciation		NA		NA
CASH BALANCE (Net Income – Principals + Depreciation)		(c) NA		(d) NA

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	NA	(a) – (b)
ANNUAL CASH BALANCE DIFFERENCE	NA	(c) – (d)

Catfish CONSTRUCTION COSTS

DIRT VOLUME per LINEAR FOOT CALCULATION

A = TOP Width	14	Ft.	<-Insert
B = BASE Width	60	Ft.	B = (S1+S2) x H + A
H = HEIGHT	6.5	Ft.	<-Insert
S1 = INNER SLOPE	3.0	Ft.	<-Insert
S2 = OUTER SLOPE	4.0	Ft.	<-Insert

DIRT VOLUME AND COST CALCULATIONS

VOLUME = 239 CU. FT. per LINEAR FT. (A + B)/2 x H

LENGTH = 11,200 LINEAR FT. <-Insert

TOTAL
VOLUME = 99,089 CU. YDS (VOLUME x LENGTH / 27)

DIRT MOVING
COST: $0.60 PER CU. YD. <-Insert

USCOE'S CONSTRUCTION COSTS

A. LEVEE (Dirt Moving) COST	$59,453	(Dirt Moving Cost x Total Volume)	
B. WATER CONTROL STRUCTURE(S)	15,000	<-Insert	
C. ACCESS ROAD	$2,000	<-Insert	
D. PRECONSTRUCTION COSTS (permits, tests, etc.)	$10,000	<-Insert	
USCOE'S Total Construction Costs (A, B, C, D)			$86,453

AQUACULTURIST'S CONSTRUCTION COSTS

E: POND IMPROVEMENTS (seeding, shaping, etc.)	$2,000	<-Insert	
F. SITE IMPROVEMENTS & UTILITIES (piers, pilings, septic system, electricity, water, etc.)	$6,000	<-Insert	
G. PRECONSTRUCTION COSTS (permits, tests, etc.)	$6,000	<-Insert	
H. CONSTRUCTION SUPERVISION	$2,000	<-Insert	
Aquaculturist's Total Construction Costs (E, F, G, H)			$16,000
USCOE & AQUACULTURIST'S TOTAL CONSTRUCTION COSTS			$102,453

Catfish

INITIAL INVESTMENT COSTS

EQUIPMENT COSTS

AERATOR & SCREEN	$12,000	<— Insert
BOAT & MOTOR	1,425	<— Insert
BUILDING (Feed Storage)	5,000	<— Insert
BUILDING (Office/Service)	8,500	<— Insert
CHEMICALS		<— Insert
COOLERS		<— Insert
FEED BINS		<— Insert
FEEDERS	3,000	<— Insert
FLOATS		<— Insert
GENERATORS		<— Insert
HARVEST BASKETS		<— Insert
HARVEST MACHINE		<— Insert
MESH BAGS		<— Insert
MOWER	2,000	<— Insert
NETS		<— Insert
NIGHT LIGHTS		<— Insert
PUMP SHED	1,200	<— Insert
TRAILER		<— Insert
TRAPS		<— Insert
VALVES	1,000	<— Insert
VEHICLES	18,000	<— Insert
WATER PIPE	2,200	<— Insert
WELL & PUMPS	12,000	<— Insert
WET SUIT / SCUBA		<— Insert
OTHER: Miscellaneous	1,400	<— Insert
OTHER: ______		<— Insert
OTHER: ______		<— Insert
OTHER: ______		<— Insert
TOTAL EQUIPMENT COST	$67,725	

INITIAL INVESTMENT COSTS SUMMARY

Aquaculturist's Investment Costs			
Total Equipment Costs	$67,725		
Total Construction Costs (Page 1):	16,000		
Total Investment Costs		$83,725	
USCOE'S Investment Costs			
Total Construction Costs (Page 1)		$86,453	
Total Aquaculturist's & USCOE'S Initial Investment Costs			$170,178

Catfish

ANNUAL VARIABLE COSTS

VARIABLE PRODUCTION COSTS

BAIT		<--Insert
CHEMICALS	5,600	<--Insert
FEED	70,000	<--Insert
FERTILIZER		<--Insert
FINGERLINGS / POSTLARVAE	19,600	<--Insert
FUEL	2,500	<--Insert
HARVESTING	16,800	<--Insert
HAULING		<--Insert
HIRED LABOR & PAYROLL TAX	2,400	<--Insert
ICE		<--Insert
MANAGER		<--Insert
PROCESSING		<--Insert
REPAIRS & MAINTENANCE	14,000	<--Insert
SACKS		<--Insert
SEED		<--Insert
SUPPLIES		<--Insert
TRANSPORTATION		<--Insert
UTILITIES (Electricity, Telephone, Etc.)	8,000	<--Insert
OTHER: ____________		<--Insert
OTHER: ____________		<--Insert
OTHER: ____________		<--Insert
OTHER: ____________		<--Insert
A. SUB-TOTAL VARIABLE COSTS	$138,900	

OPERATING LOAN COSTS

B. % of Variable Costs borrowed	75%	<--Insert
C. Total Amount of Operating Loan	$104,175	(A x B)
D. Term of Operating Loan (# of Yrs.)	5	<--Insert
E. Annual Operating Loan Payment	$20,835	(C / D)
F. % of Interest on Operating Loan	12%	<--Insert
G. Interest Paid on Operating Loan	$12,501	(C x F)
H. TOTAL VARIABLE COSTS	$151,401	(A + G)

Catfish

ANNUAL FIXED COSTS

AQUACULTURIST'S EXPENDITURES / DEPRECIATION

A.	Total Investment Costs	$83,725	(From Page 2)
B.	Amortization Schedule (Years)	5	<--Insert
C.	Annual Investment Depreciation	$16,745	(A / B)
D.	% of Initial Investment Borrowed	75%	<--Insert
E.	Amount of Investment Loan	$62,794	(A x D)
F.	Term of Loan (# Yrs.)	10	<--Insert
G.	Annual Principal Payment	$6,279	(E / F)
H.	% of Interest on Investment Loan	15%	<--Insert
I.	Interest Paid on Investment Loan	$9,419	(E x H)
J.	Annual Insurance Premiums	$2,000	<--Insert
K.	Salaried Employees and Payroll Taxes		<--Insert
L.	Miscellaneous		<--Insert
M.	Other ____________		<--Insert
	TOTAL FIXED COSTS	$28,164	(C+I+J+K)

AQUACULTURIST'S FIXED-COST SAVINGS
(Based on Value of USCOE'S Contribution to Total Construction Costs)

AA.	USCOE'S Total Construction Costs	$86,453	(From Page 1)
BB.	Amortization Schedule (Years)	5	(B above)
CC.	Annual Investment Depreciation	$17,291	(AA / BB)
DD.	% of Initial Investment Borrowed	75%	(D above)
EE.	Total Amount of Investment Loan	$64,840	(AA x DD)
FF.	Term of Loan (# Yrs.)	10	(F Above)
GG.	Annual Principal Payment	$6,484	(EE / FF)
HH.	% of Interest on Investment Loan	15%	(H above)
II.	Interest Paid on Investment Loan	$9,726	(EE x HH)
	AQUACULTURIST'S FIXED-COST SAVINGS	$27,017	(CC + II)

ANNUAL SALES SUMMARY

SPECIES: Catfish

UNIT: Pounds

HARVEST 1

TOTAL UNITS HARVESTED	280,000	<--Insert
PRICE PER UNIT	$0.75	<--Insert
AMOUNT OF SALE	$210,000	(Units Harvested x Price per Unit)
NUMBER OF ACRES	80	<--Insert
UNITS HARVESTED / PER ACRE	3,500	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$2,625	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	80	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$210,000	(Harvests 1 & 2)

Catfish

ANNUAL INCOME STATEMENT

REVENUE	With USCOE		W/out USCOE	
Total Annual Sales		$210,000		$210,000
EXPENSES				
A. Total Variable Costs (Pg. 3)	$151,401		$151,401	
B. Total Fixed Costs (Pg. 4)	$28,164		$28,164	
Total Expenses with USCOE		$179,565		$179,565
C. USCOE FIXED-COSTS SAVINGS (Pg. 4)			$27,017	
Total Expenses w/out USCOE				$206,582
NET INCOME		(a) $30,435		(b) $3,418

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$30,435		$3,418
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$20,835		$20,835	
Investment Loan Payment (Pg. 4, G)	$6,279		$6,279	
Total Loan Pricipals		$27,114		$27,114
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed-Cost Savings)				$6,484
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	$16,745		$16,745	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$17,291	
Total Depreciation		$16,745		$34,036
CASH BALANCE (Net Income – Principals + Depreciation)		(c) $20,066		(d) $3,856

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$27,017	(a) – (b)
ANNUAL CASH BALANCE DIFFERENCE	$16,210	(c) – (d)

ANNUAL SALES SUMMARY

SPECIES: Catfish

UNIT: Pounds

HARVEST 1

TOTAL UNITS HARVESTED	280,000	<--Insert
PRICE PER UNIT	$0.65	<--Insert
AMOUNT OF SALE	$182,000	(Units Harvested x Price per Unit)
NUMBER OF ACRES	80	<--Insert
UNITS HARVESTED / PER ACRE	3,500	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$2,275	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	80	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$182,000	(Harvests 1 & 2)

Catfish

ANNUAL INCOME STATEMENT

REVENUE	With USCOE		W/out USCOE	
Total Annual Sales		$182,000		$182,000
EXPENSES				
A. Total Variable Costs (Pg. 3)	$151,401		$151,401	
B. Total Fixed Costs (Pg. 4)	$28,164		$28,164	
Total Expenses with USCOE		$179,565		$179,565
C. USCOE FIXED-COSTS SAVINGS (Pg. 4)			$27,017	
Total Expenses w/out USCOE				$206,582
NET INCOME	(a)	$2,435	(b)	($24,582)

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$2,435		($24,582)
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$20,835		$20,835	
Investment Loan Payment (Pg. 4, G)	$6,279		$6,279	
Total Loan Pricipals		$27,114		$27,114
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed-Cost Savings)				$6,484
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	$16,745		$16,745	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$17,291	
Total Depreciation		$16,745		$34,036
CASH BALANCE (Net Income - Principals + Depreciation)	(c)	($7,934)	(d)	($24,144)

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$27,017	(a) - (b)
ANNUAL CASH BALANCE DIFFERENCE	$16,210	(c) - (d)

ANNUAL SALES SUMMARY

SPECIES: Catfish

UNIT: Pounds

HARVEST 1

TOTAL UNITS HARVESTED	240,000	<--Insert
PRICE PER UNIT	$0.75	<--Insert
AMOUNT OF SALE	$180,000	(Units Harvested x Price per Unit)
NUMBER OF ACRES	80	<--Insert
UNITS HARVESTED / PER ACRE	3,000	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$2,250	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	80	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$180,000	(Harvests 1 & 2)

Catfish

ANNUAL INCOME STATEMENT

REVENUE	*With USCOE*		*W/out USCOE*	
Total Annual Sales		$180,000		$180,000
EXPENSES				
A. Total Variable Costs (Pg. 3)	$151,401		$151,401	
B. Total Fixed Costs (Pg. 4)	$28,164		$28,164	
Total Expenses with USCOE		$179,565		$179,565
C. USCOE FIXED-COSTS SAVINGS (Pg. 4)			$27,017	
Total Expenses w/out USCOE				$206,582
NET INCOME	(a)	$435	(b)	($26,582)

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$435		($26,582)
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$20,835		$20,835	
Investment Loan Payment (Pg. 4, G)	$6,279		$6,279	
Total Loan Pricipals		$27,114		$27,114
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed-Cost Savings)				$6,484
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	$16,745		$16,745	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$17,291	
Total Depreciation		$16,745		$34,036
CASH BALANCE (Net Income - Principals + Depreciation)	(c)	($9,934)	(d)	($26,144)

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$27,017	(a) - (b)
ANNUAL CASH BALANCE DIFFERENCE	$16,210	(c) - (d)

Crawfish CONSTRUCTION COSTS

DIRT VOLUME per LINEAR FOOT CALCULATION

A = TOP Width	2	Ft.	<-Insert
B = BASE Width	14	Ft.	B = (S1+S2) x H + A
H = HEIGHT	3.0	Ft.	<-Insert
S1 = INNER SLOPE	2.0	Ft.	<-Insert
S2 = OUTER SLOPE	2.0	Ft.	<-Insert

DIRT VOLUME AND COST CALCULATIONS

VOLUME = 24 CU. FT. per LINEAR FT. (A + B)/2 x H

LENGTH = 1,320 LINEAR FT. <-Insert

TOTAL VOLUME = 1,173 CU. YDS (VOLUME x LENGTH / 27)

DIRT MOVING COST: $0.60 PER CU. YD. <-Insert

USCOE'S CONSTRUCTION COSTS

A. LEVEE (Dirt Moving) COST	$704	(Dirt Moving Cost x Total Volume)	
B. WATER CONTROL STRUCTURE(S)	1,500	<-Insert	
C. ACCESS ROAD	$0	<-Insert	
D. PRECONSTRUCTION COSTS (permits, tests, etc.)	$15,000	<-Insert	
USCOE'S Total Construction Costs (A, B, C, D)			$17,204

AQUACULTURIST'S CONSTRUCTION COSTS

E: POND IMPROVEMENTS (seeding, shaping, etc.)	$300	<-Insert	
F. SITE IMPROVEMENTS & UTILITIES (piers, pilings, septic system, electricity, water, etc.)	$0	<-Insert	
G. PRECONSTRUCTION COSTS (permits, tests, etc.)	$1,000	<-Insert	
H. CONSTRUCTION SUPERVISION	$0	<-Insert	
Aquaculturist's Total Construction Costs (E, F, G, H)			$1,300
USCOE & AQUACULTURIST'S TOTAL CONSTRUCTION COSTS			$18,504

Crawfish INITIAL INVESTMENT COSTS

EQUIPMENT COSTS

AERATOR & SCREEN	$500	<— Insert
BOAT & MOTOR		<— Insert
BUILDING (Feed Storage)	500	<— Insert
BUILDING (Office/Service)		<— Insert
CHEMICALS		<— Insert
COOLERS	1,200	<— Insert
FEED BINS		<— Insert
FEEDERS		<— Insert
FLOATS		<— Insert
GENERATORS		<— Insert
HARVEST BASKETS		<— Insert
HARVEST MACHINE	5,000	<— Insert
MESH BAGS		<— Insert
MOWER	600	<— Insert
NETS		<— Insert
NIGHT LIGHTS		<— Insert
PUMP SHED	400	<— Insert
TRAILER		<— Insert
TRAPS		<— Insert
VALVES		<— Insert
VEHICLES	6,500	<— Insert
WATER PIPE		<— Insert
WELL & PUMPS	10,000	<— Insert
WET SUIT / SCUBA		<— Insert
OTHER: Miscellaneous	500	<— Insert
OTHER: ____________		<— Insert
OTHER: ____________		<— Insert
OTHER: ____________		<— Insert
TOTAL EQUIPMENT COST	$25,200	

INITIAL INVESTMENT COSTS SUMMARY

Aquaculturist's Investment Costs			
Total Equipment Costs	$25,200		
Total Construction Costs (Page 1):	1,300		
Total Investment Costs		$26,500	
USCOE'S Investment Costs			
Total Construction Costs (Page 1)		$17,204	
Total Aquaculturist's & USCOE'S Initial Investment Costs			$43,704

Crawfish ANNUAL VARIABLE COSTS

VARIABLE PRODUCTION COSTS

BAIT	$5,500	<--Insert
CHEMICALS		<--Insert
FEED	1,600	<--Insert
FERTILIZER		<--Insert
FINGERLINGS / POSTLARVAE		<--Insert
FUEL	1,800	<--Insert
HARVESTING		<--Insert
HAULING		<--Insert
HIRED LABOR & PAYROLL TAX	1,500	<--Insert
ICE		<--Insert
MANAGER		<--Insert
PROCESSING		<--Insert
REPAIRS & MAINTENANCE	1,100	<--Insert
SACKS	200	<--Insert
SEED		<--Insert
SUPPLIES		<--Insert
TRANSPORTATION		<--Insert
UTILITIES (Electricity, Telephone, Etc.)		<--Insert
OTHER: ____________		<--Insert
OTHER: ____________		<--Insert
OTHER: ____________		<--Insert
OTHER: ____________		<--Insert
A. SUB-TOTAL VARIABLE COSTS	$11,700	

OPERATING LOAN COSTS

B. % of Variable Costs borrowed	25%	<--Insert
C. Total Amount of Operating Loan	$2,925	(A x B)
D. Term of Operating Loan (# of Yrs.)	5	<--Insert
E. Annual Operating Loan Payment	$585	(C / D)
F. % of Interest on Operating Loan	15%	<--Insert
G. Interest Paid on Operating Loan	$439	(C x F)
H. TOTAL VARIABLE COSTS	$12,139	(A + G)

Crawfish ANNUAL FIXED COSTS

AQUACULTURIST'S EXPENDITURES / DEPRECIATION

A.	Total Investment Costs	ERR	(From Page 2)
B.	Amortization Schedule (Years)	5	<--Insert
C.	Annual Investment Depreciation	ERR	(A / B)
D.	% of Initial Investment Borrowed	50%	<--Insert
E.	Amount of Investment Loan	ERR	(A x D)
F.	Term of Loan (# Yrs.)	5	<--Insert
G.	Annual Principal Payment	ERR	(E / F)
H.	% of Interest on Investment Loan	15%	<--Insert
I.	Interest Paid on Investment Loan	ERR	(E x H)
J.	Annual Insurance Premiums		<--Insert
K.	Salaried Employees and Payroll Taxes	$0	<--Insert
L.	Miscellaneous	$0	<--Insert
M.	Other ____________		<--Insert
	TOTAL FIXED COSTS	ERR	(C+I+J+K)

AQUACULTURIST'S FIXED–COST SAVINGS

(Based on Value of USCOE'S Contribution to Total Construction Costs)

AA.	USCOE'S Total Construction Costs	$17,204	(From Page 1)
BB.	Amortization Schedule (Years)	5	(B above)
CC.	Annual Investment Depreciation	$3,441	(AA / BB)
DD.	% of Initial Investment Borrowed	50%	(D above)
EE.	Total Amount of Investment Loan	$8,602	(AA x DD)
FF.	Term of Loan (# Yrs.)	5	(F Above)
GG.	Annual Principal Payment	$1,720	(EE / FF)
HH.	% of Interest on Investment Loan	15%	(H above)
II.	Interest Paid on Investment Loan	$1,290	(EE x HH)
	AQUACULTURIST'S FIXED–COST SAVINGS	$4,731	(CC + II)

ANNUAL SALES SUMMARY

SPECIES: Crawfish

UNIT: Pounds

HARVEST 1

TOTAL UNITS HARVESTED	40,000	<--Insert
PRICE PER UNIT	$0.60	<--Insert
AMOUNT OF SALE	$24,000	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	1,000	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$600	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$24,000	(Harvests 1 & 2)

<u>Crawfish</u>

ANNUAL INCOME STATEMENT

REVENUE	*With USCOE*		*W/out USCOE*	
Total Annual Sales		$24,000		$24,000
EXPENSES				
A. Total Variable Costs (Pg. 3)	$12,139		$12,139	
B. Total Fixed Costs (Pg. 4)	$7,288		$7,288	
Total Expenses with USCOE		$19,426		$19,426
C. USCOE FIXED-COSTS SAVINGS (Pg. 4)			$4,731	
Total Expenses w/out USCOE				$24,157
NET INCOME		(a) $4,574		(b) ($157)

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$4,574		($157)
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$585		$585	
Investment Loan Payment (Pg. 4, G)	$2,650		$2,650	
Total Loan Pricipals		$3,235		$3,235
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed-Cost Savings)				$1,720
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	$5,300		$5,300	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$3,441	
Total Depreciation		$5,300		$8,741
CASH BALANCE (Net Income – Principals + Depreciation)		(c) $6,639		(d) $3,628

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$4,731	(a) – (b)
ANNUAL CASH BALANCE DIFFERENCE	$3,011	(c) – (d)

ANNUAL SALES SUMMARY

SPECIES: Crawfish

UNIT: Pounds

HARVEST 1

TOTAL UNITS HARVESTED	40,000	<--Insert
PRICE PER UNIT	$0.49	<--Insert
AMOUNT OF SALE	$19,600	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	1,000	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$490	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES $19,600 (Harvests 1 & 2)

Crawfish

ANNUAL INCOME STATEMENT

REVENUE		*With USCOE*		*W/out USCOE*
Total Annual Sales		$19,600		$19,600
EXPENSES				
A. Total Variable Costs (Pg. 3)	$12,139		$12,139	
B. Total Fixed Costs (Pg. 4)	$7,288		$7,288	
Total Expenses with USCOE		$19,426		$19,426
C. USCOE FIXED–COSTS SAVINGS (Pg. 4)			$4,731	
Total Expenses w/out USCOE				$24,157
NET INCOME	(a)	$174	(b)	($4,557)

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$174		($4,557)
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$585		$585	
Investment Loan Payment (Pg. 4, G)	$2,650		$2,650	
Total Loan Pricipals		$3,235		$3,235
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed–Cost Savings)				$1,720
DEPRECIATION				
Aquaculturist's Investment (Pg. 4. C)	$5,300		$5,300	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$3,441	
Total Depreciation		$5,300		$8,741
CASH BALANCE (Net income – Principals + Depreciation)	(c)	$2,239	(d)	($772)

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$4,731	(a) – (b)
ANNUAL CASH BALANCE DIFFERENCE	$3,011	(c) – (d)

ANNUAL SALES SUMMARY

SPECIES: Crawfish

UNIT: Pounds

HARVEST 1

TOTAL UNITS HARVESTED	33,000	<--Insert
PRICE PER UNIT	$0.60	<--Insert
AMOUNT OF SALE	$19,800	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	825	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$495	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$19,800	(Harvests 1 & 2)

Crawfish

ANNUAL INCOME STATEMENT

REVENUE	*With USCOE*		*W/out USCOE*	
Total Annual Sales		$19,800		$19,800
EXPENSES				
A. Total Variable Costs (Pg. 3)	$12,139		$12,139	
B. Total Fixed Costs (Pg. 4)	$7,288		$7,288	
Total Expenses with USCOE		$19,426		$19,426
C. USCOE FIXED-COSTS SAVINGS (Pg. 4)			$4,731	
Total Expenses w/out USCOE				$24,157
NET INCOME	(a)	$374	(b)	($4,357)

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$374		($4,357)
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$585		$585	
Investment Loan Payment (Pg. 4, G)	$2,650		$2,650	
Total Loan Pricipals		$3,235		$3,235
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed-Cost Savings)				$1,720
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	$5,300		$5,300	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$3,441	
Total Depreciation		$5,300		$8,741
CASH BALANCE (Net Income - Principals + Depreciation)	(c)	$2,439	(d)	($572)

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$4,731	(a) - (b)
ANNUAL CASH BALANCE DIFFERENCE	$3,011	(c) - (d)

Clams

CONSTRUCTION COSTS

DIRT VOLUME per LINEAR FOOT CALCULATION

A = TOP Width	2	Ft.	<-Insert
B = BASE Width	14	Ft.	B = (S1+S2) x H + A
H = HEIGHT	3.0	Ft.	<-Insert
S1 = INNER SLOPE	2.0	Ft.	<-Insert
S2 = OUTER SLOPE	2.0	Ft.	<-Insert

DIRT VOLUME AND COST CALCULATIONS

VOLUME = 24 CU. FT. per LINEAR FT. (A + B)/2 x H

LENGTH = 1,320 LINEAR FT. <-Insert

TOTAL VOLUME = 1,173 CU. YDS (VOLUME x LENGTH / 27)

DIRT MOVING COST: $0.60 PER CU. YD. <-Insert

USCOE'S CONSTRUCTION COSTS

A. LEVEE (Dirt Moving) COST	$704	(Dirt Moving Cost x Total Volume)	
B. WATER CONTROL STRUCTURE(S)	8,000	<-Insert	
C. ACCESS ROAD	$0	<-Insert	
D. PRECONSTRUCTION COSTS (permits, tests, etc.)	$15,000	<-Insert	
USCOE'S Total Construction Costs (A, B, C, D)			$23,704

AQUACULTURIST'S CONSTRUCTION COSTS

E: POND IMPROVEMENTS (seeding, shaping, etc.)	$300	<-Insert	
F. SITE IMPROVEMENTS & UTILITIES (piers, pilings, septic system, electricity, water, etc.)	$1,500	<-Insert	
G. PRECONSTRUCTION COSTS (permits, tests, etc.)	$1,500	<-Insert	
H. CONSTRUCTION SUPERVISION	$500	<-Insert	
Aquaculturist's Total Construction Costs (E, F, G, H)			$3,800
USCOE & AQUACULTURIST'S TOTAL CONSTRUCTION COSTS			$27,504

Clams

INITIAL INVESTMENT COSTS

EQUIPMENT COSTS

AERATOR & SCREEN		<— Insert
BOAT & MOTOR	8,500	<— Insert
BUILDING (Feed Storage)		<— Insert
BUILDING (Office/Service)		<— Insert
CHEMICALS		<— Insert
COOLERS		<— Insert
FEED BINS		<— Insert
FEEDERS		<— Insert
FLOATS	600	<— Insert
GENERATORS		<— Insert
HARVEST BASKETS		<— Insert
HARVEST MACHINE		<— Insert
MESH BAGS	18,200	<— Insert
MOWER		<— Insert
NETS		<— Insert
NIGHT LIGHTS		<— Insert
PUMP SHED		<— Insert
TRAILER	1,000	<— Insert
TRAPS		<— Insert
VALVES		<— Insert
VEHICLES	11,000	<— Insert
WATER PIPE		<— Insert
WELL & PUMPS	500	<— Insert
WET SUIT / SCUBA	1,100	<— Insert
OTHER: Miscellaneous	800	<— Insert
OTHER: ____________		<— Insert
OTHER: ____________		<— Insert
OTHER: ____________		<— Insert
TOTAL EQUIPMENT COST	$41,700	

INITIAL INVESTMENT COSTS SUMMARY

Aquaculturist's Investment Costs			
Total Equipment Costs	$41,700		
Total Construction Costs (Page 1):	3,800		
Total Investment Costs		$45,500	
USCOE'S Investment Costs			
Total Construction Costs (Page 1)		$23,704	
Total Aquaculturist's & USCOE'S Initial Investment Costs			$69,204

C'ams

ANNUAL VARIABLE COSTS

VARIABLE PRODUCTION COSTS

BAIT		<--Insert
CHEMICALS		<--Insert
FEED		<--Insert
FERTILIZER		<--Insert
FINGERLINGS / POSTLARVAE		<--Insert
FUEL	1,900	<--Insert
HARVESTING		<--Insert
HAULING		<--Insert
HIRED LABOR & PAYROLL TAX	2,500	<--Insert
ICE		<--Insert
MANAGER		<--Insert
PROCESSING		<--Insert
REPAIRS & MAINTENANCE	1,800	<--Insert
SACKS		<--Insert
SEED	40,000	<--Insert
SUPPLIES	200	<--Insert
TRANSPORTATION		<--Insert
UTILITIES (Electricity, Telephone, Etc.)		<--Insert
OTHER: ____________		<--Insert
OTHER: ____________		<--Insert
OTHER: ____________		<--Insert
OTHER: ____________		<--Insert
A. SUB-TOTAL VARIABLE COSTS	$46,400	

OPERATING LOAN COSTS

B. % of Variable Costs borrowed	50%	<--Insert
C. Total Amount of Operating Loan	$23,200	(A x B)
D. Term of Operating Loan (# of Yrs.)	5	<--Insert
E. Annual Operating Loan Payment	$4,640	(C / D)
F. % of Interest on Operating Loan	12%	<--Insert
G. Interest Paid on Operating Loan	$2,784	(C x F)
H. TOTAL VARIABLE COSTS	$49,184	(A + G)

Clams

ANNUAL FIXED COSTS

AQUACULTURIST'S EXPENDITURES / DEPRECIATION

A.	Total Investment Costs	$45,500	(From Page 2)
B.	Amortization Schedule (Years)	5	<--Insert
C.	Annual Investment Depreciation	$9,100	(A / B)
D.	% of Initial Investment Borrowed	50%	<--Insert
E.	Amount of Investment Loan	$22,750	(A x D)
F.	Term of Loan (# Yrs.)	10	<--Insert
G.	Annual Principal Payment	$2,275	(E / F)
H.	% of Interest on Investment Loan	12%	<--Insert
I.	Interest Paid on Investment Loan	$2,730	(E x H)
J.	Annual Insurance Premiums	$1,000	<--Insert
K.	Salaried Employees and Payroll Taxes	$0	<--Insert
L.	Miscellaneous	$1,400	<--Insert
M.	Other ____________		<--Insert
	TOTAL FIXED COSTS	$12,830	(C+I+J+K)

AQUACULTURIST'S FIXED-COST SAVINGS
(Based on Value of USCOE'S Contribution to Total Construction Costs)

AA.	USCOE'S Total Construction Costs	$23,704	(From Page 1)
BB.	Amortization Schedule (Years)	5	(B above)
CC.	Annual Investment Depreciation	$4,741	(AA / BB)
DD.	% of Initial Investment Borrowed	50%	(D above)
EE.	Total Amount of Investment Loan	$11,852	(AA x DD)
FF.	Term of Loan (# Yrs.)	10	(F Above)
GG.	Annual Principal Payment	$1,185	(EE / FF)
HH.	% of Interest on Investment Loan	12%	(H above)
II.	Interest Paid on Investment Loan	$1,422	(EE x HH)
	AQUACULTURIST'S FIXED-COST SAVINGS	$6,163	(CC + II)

09/30/90

U.S. ARMY CORPS OF ENGINEERS
CONTAINMENT AREA AQUACULTURE PROGRAM
ECONOMICS AND MARKETING WORKSHEET

ANNUAL SALES SUMMARY

SPECIES: Clams

UNIT: Each

HARVEST 1

TOTAL UNITS HARVESTED	1,000,000	<--Insert
PRICE PER UNIT	$0.17	<--Insert
AMOUNT OF SALE	$170,000	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	25,000	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$4,250	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$170,000	(Harvests 1 & 2)

Clams

ANNUAL INCOME STATEMENT

REVENUE		*With USCOE*		*W/out USCOE*
Total Annual Sales		$170,000		$170,000
EXPENSES				
A. Total Variable Costs (Pg. 3)	$49,184		$49,184	
B. Total Fixed Costs (Pg. 4)	$12,830		$12,830	
Total Expenses with USCOE		$62,014		$62,014
C. USCOE FIXED–COSTS SAVINGS (Pg. 4)			$6,163	
Total Expenses w/out USCOE				$68,177
NET INCOME		(a) $107,986		(b) $101,823

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$107,986		$101,823
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$4,640		$4,640	
Investment Loan Payment (Pg. 4, G)	$2,275		$2,275	
Total Loan Pricipals		$6,915		$6,915
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed–Cost Savings)				$1,185
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	$9,100		$9,100	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$4,741	
Total Depreciation		$9,100		$13,841
CASH BALANCE (Net Income – Principals + Depreciation)		(c) $110,171		(d) $107,564

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$6,163	(a) – (b)
ANNUAL CASH BALANCE DIFFERENCE	$2,607	(c) – (d)

ANNUAL SALES SUMMARY

SPECIES: Clams

UNIT: Each

HARVEST 1

TOTAL UNITS HARVESTED	1,000,000	<--Insert
PRICE PER UNIT	$0.09	<--Insert
AMOUNT OF SALE	$90,000	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	25,000	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$2,250	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$90,000	(Harvests 1 & 2)

Clams

ANNUAL INCOME STATEMENT

	With USCOE		W/out USCOE	
REVENUE				
Total Annual Sales		$90,000		$90,000
EXPENSES				
A. Total Variable Costs (Pg. 3)	$49,184		$49,184	
B. Total Fixed Costs (Pg. 4)	$12,830		$12,830	
Total Expenses with USCOE		$62,014		$62,014
C. USCOE FIXED–COSTS SAVINGS (Pg. 4)			$6,163	
Total Expenses w/out USCOE				$68,177
NET INCOME	(a)	$27,986	(b)	$21,823

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$27,986		$21,823
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$4,640		$4,640	
Investment Loan Payment (Pg. 4, G)	$2,275		$2,275	
Total Loan Pricipals		$6,915		$6,915
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed–Cost Savings)				$1,185
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	$9,100		$9,100	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$4,741	
Total Depreciation		$9,100		$13,841
CASH BALANCE (Net Income – Principals + Depreciation)	(c)	$30,171	(d)	$27,564

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$6,163	(a) – (b)
ANNUAL CASH BALANCE DIFFERENCE	$2,607	(c) – (d)

ANNUAL SALES SUMMARY

SPECIES: Clams

UNIT: Each

HARVEST 1

TOTAL UNITS HARVESTED	500,000	<--Insert
PRICE PER UNIT	$0.17	<--Insert
AMOUNT OF SALE	$85,000	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	12,500	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$2,125	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$85,000	(Harvests 1 & 2)

Clams

ANNUAL INCOME STATEMENT

REVENUE		*With USCOE*			*W/out USCOE*
Total Annual Sales			$85,000		$85,000
EXPENSES					
A. Total Variable Costs (Pg. 3)	$49,184			$49,184	
B. Total Fixed Costs (Pg. 4)	$12,830			$12,830	
Total Expenses with USCOE			$62,014		$62,014
C. USCOE FIXED-COSTS SAVINGS (Pg. 4)				$6,163	
Total Expenses w/out USCOE					$68,177
NET INCOME		(a)	$22,986	(b)	$16,823

ANNUAL CASH BALANCE STATEMENT

NET INCOME			$22,986		$16,823
LOAN PRINCIPALS					
Operating Loan Payment (Pg. 3, E)	$4,640			$4,640	
Investment Loan Payment (Pg. 4, G)	$2,275			$2,275	
Total Loan Pricipals			$6,915		$6,915
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed-Cost Savings)					$1,185
DEPRECIATION					
Aquaculturist's Investment (Pg. 4, C)	$9,100			$9,100	
USCOE Investment (Savings) (Pg. 4, CC)	$0			$4,741	
Total Depreciation			$9,100		$13,841
CASH BALANCE (Net Income - Principals + Depreciation)		(c)	$25,171	(d)	$22,564

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$6,163	(a) - (b)
ANNUAL CASH BALANCE DIFFERENCE	$2,607	(c) - (d)

Hybrid Striped Bass CONSTRUCTION COSTS

DIRT VOLUME per LINEAR FOOT CALCULATION

A = TOP Width	13	Ft.	<-Insert
B = BASE Width	59	Ft.	B = (S1+S2) x H + A
H = HEIGHT	6.5	Ft.	<-Insert
S1 = INNER SLOPE	4.0	Ft.	<-Insert
S2 = OUTER SLOPE	3.0	Ft.	<-Insert

DIRT VOLUME AND COST CALCULATIONS

VOLUME = 232 CU. FT. per LINEAR FT. (A + B)/2 x H

LENGTH = 6,600 LINEAR FT. <-Insert

TOTAL VOLUME = 56,803 CU. YDS (VOLUME x LENGTH / 27)

DIRT MOVING COST: $0.60 PER CU. YD. <-Insert

USCOE'S CONSTRUCTION COSTS

A. LEVEE (Dirt Moving) COST	$34,082	(Dirt Moving Cost x Total Volume)	
B. WATER CONTROL STRUCTURE(S)	7,800	<-Insert	
C. ACCESS ROAD	$3,000	<-Insert	
D. PRECONSTRUCTION COSTS (permits, tests, etc.)	$10,000	<-Insert	
USCOE'S Total Construction Costs (A, B, C, D)			$54,882

AQUACULTURIST'S CONSTRUCTION COSTS

E: POND IMPROVEMENTS (seeding, shaping, etc.)	$1,000	<-Insert	
F. SITE IMPROVEMENTS & UTILITIES (piers, pilings, septic system, electricity, water, etc.)	$3,000	<-Insert	
G. PRECONSTRUCTION COSTS (permits, tests, etc.)	$6,000	<-Insert	
H. CONSTRUCTION SUPERVISION	$1,000	<-Insert	
Aquaculturist's Total Construction Costs (E, F, G, H)			$11,000
USCOE & AQUACULTURIST'S TOTAL CONSTRUCTION COSTS			$65,882

Hybrid Striped Bass INITIAL INVESTMENT COSTS

EQUIPMENT COSTS

AERATOR & SCREEN	$12,000	<— Insert
BOAT & MOTOR	1,425	<— Insert
BUILDING (Feed Storage)	5,000	<— Insert
BUILDING (Office/Service)	8,500	<— Insert
CHEMICALS		<— Insert
COOLERS		<— Insert
FEED BINS		<— Insert
FEEDERS	3,000	<— Insert
FLOATS		<— Insert
GENERATORS		<— Insert
HARVEST BASKETS		<— Insert
HARVEST MACHINE		<— Insert
MESH BAGS		<— Insert
MOWER	2,000	<— Insert
NETS		<— Insert
NIGHT LIGHTS		<— Insert
PUMP SHED	1,200	<— Insert
TRAILER		<— Insert
TRAPS		<— Insert
VALVES	1,000	<— Insert
VEHICLES	18,000	<— Insert
WATER PIPE	2,200	<— Insert
WELL & PUMPS	12,000	<— Insert
WET SUIT / SCUBA		<— Insert
OTHER: Miscellaneous	1,400	<— Insert
OTHER: ____________		<— Insert
OTHER: ____________		<— Insert
OTHER: ____________		<— Insert
TOTAL EQUIPMENT COST	$67,725	

INITIAL INVESTMENT COSTS SUMMARY

Aquaculturist's Investment Costs			
Total Equipment Costs	$67,725		
Total Construction Costs (Page 1):	11,000		
Total Investment Costs		$78,725	
USCOE'S Investment Costs			
Total Construction Costs (Page 1)		$54,882	
Total Aquaculturist's & USCOE'S Initial Investment Costs			$133,607

Hybrid Striped Bass ANNUAL VARIABLE COSTS

VARIABLE PRODUCTION COSTS

BAIT		<--Insert
CHEMICALS	600	<--Insert
FEED	65,000	<--Insert
FERTILIZER		<--Insert
FINGERLINGS / POSTLARVAE	16,000	<--Insert
FUEL	6,800	<--Insert
HARVESTING	5,500	<--Insert
HAULING		<--Insert
HIRED LABOR & PAYROLL TAX	2,500	<--Insert
ICE		<--Insert
MANAGER		<--Insert
PROCESSING		<--Insert
REPAIRS & MAINTENANCE	8,000	<--Insert
SACKS		<--Insert
SEED		<--Insert
SUPPLIES		<--Insert
TRANSPORTATION		<--Insert
UTILITIES (Electricity, Telephone, Etc.)	1,500	<--Insert
OTHER: ________		<--Insert
OTHER: ________		<--Insert
OTHER: ________		<--Insert
OTHER: ________		<--Insert
A. SUB-TOTAL VARIABLE COSTS	$105,900	

OPERATING LOAN COSTS

B. % of Variable Costs borrowed	75%	<--Insert
C. Total Amount of Operating Loan	$79,425	(A x B)
D. Term of Operating Loan (# of Yrs.)	5	<--Insert
E. Annual Operating Loan Payment	$15,885	(C / D)
F. % of Interest on Operating Loan	12%	<--Insert
G. Interest Paid on Operating Loan	$9,531	(C x F)
H. TOTAL VARIABLE COSTS	$115,431	(A + G)

Hybrid Striped Bass ANNUAL FIXED COSTS

AQUACULTURIST'S EXPENDITURES / DEPRECIATION

A.	Total Investment Costs	$58,600	(From Page 2)
B.	Amortization Schedule (Years)	5	<--Insert
C.	Annual Investment Depreciation	$11,720	(A / B)
D.	% of Initial Investment Borrowed	75%	<--Insert
E.	Amount of Investment Loan	$43,950	(A x D)
F.	Term of Loan (# Yrs.)	10	<--Insert
G.	Annual Principal Payment	$4,395	(E / F)
H.	% of Interest on Investment Loan	15%	<--Insert
I.	Interest Paid on Investment Loan	$6,593	(E x H)
J.	Annual Insurance Premiums	$1,500	<--Insert
K.	Salaried Employees and Payroll Taxes	$0	<--Insert
L.	Miscellaneous	$0	<--Insert
M.	Other ______________		<--Insert
	TOTAL FIXED COSTS	$19,813	(C+I+J+K)

AQUACULTURIST'S FIXED-COST SAVINGS
(Based on Value of USCOE'S Contribution to Total Construction Costs)

AA.	USCOE'S Total Construction Costs	$54,882	(From Page 1)
BB.	Amortization Schedule (Years)	5	(B above)
CC.	Annual Investment Depreciation	$10,976	(AA / BB)
DD.	% of Initial Investment Borrowed	75%	(D above)
EE.	Total Amount of Investment Loan	$41,161	(AA x DD)
FF.	Term of Loan (# Yrs.)	10	(F Above)
GG.	Annual Principal Payment	$4,116	(EE / FF)
HH.	% of Interest on Investment Loan	15%	(H above)
II.	Interest Paid on Investment Loan	$6,174	(EE x HH)
	AQUACULTURIST'S FIXED-COST SAVINGS	$17,151	(CC + II)

ANNUAL SALES SUMMARY

SPECIES: Hybrid Striped Bass

UNIT: Pounds

HARVEST 1

TOTAL UNITS HARVESTED	145,800	<--Insert
PRICE PER UNIT	$2.50	<--Insert
AMOUNT OF SALE	$364,500	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	3,645	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$9,113	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$364,500	(Harvests 1 & 2)

Hybrid Striped Bass ANNUAL INCOME STATEMENT

REVENUE	With USCOE		W/out USCOE	
Total Annual Sales		$364,500		$364,500
EXPENSES				
A. Total Variable Costs (Pg. 3)	$115,431		$115,431	
B. Total Fixed Costs (Pg. 4)	$19,813		$19,813	
Total Expenses with USCOE		$135,244		$135,244
C. USCOE FIXED-COSTS SAVINGS (Pg. 4)			$17,151	
Total Expenses w/out USCOE				$152,394
NET INCOME	(a)	$229,257	(b)	$212,106

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$229,257		$212,106
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$15,885		$15,885	
Investment Loan Payment (Pg. 4, G)	$4,395		$4,395	
Total Loan Pricipals		$20,280		$20,280
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed-Cost Savings)				$4,116
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	$11,720		$11,720	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$10,976	
Total Depreciation		$11,720		$22,696
CASH BALANCE (Net Income - Principals + Depreciation)	(c)	$220,697	(d)	$210,408

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$17,151	(a) - (b)
ANNUAL CASH BALANCE DIFFERENCE	$10,290	(c) - (d)

ANNUAL SALES SUMMARY

SPECIES: Hybrid Striped Bass

UNIT: Pounds

HARVEST 1

TOTAL UNITS HARVESTED	60,000	<-Insert
PRICE PER UNIT	$2.50	<-Insert
AMOUNT OF SALE	$150,000	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<-Insert
UNITS HARVESTED / PER ACRE	1,500	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$3,750	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<-Insert
PRICE PER UNIT	0.00	<-Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<-Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$150,000	(Harvests 1 & 2)

Hybrid Striped Bass — ANNUAL INCOME STATEMENT

REVENUE	With USCOE		W/out USCOE	
Total Annual Sales		$150,000		$150,000
EXPENSES				
A. Total Variable Costs (Pg. 3)	$115,431		$115,431	
B. Total Fixed Costs (Pg. 4)	$19,813		$19,813	
Total Expenses with USCOE		$135,244		$135,244
C. USCOE FIXED–COSTS SAVINGS (Pg. 4)			$17,151	
Total Expenses w/out USCOE				$152,394
NET INCOME	(a)	$14,757	(b)	($2,394)

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$14,757		($2,394)
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$15,885		$15,885	
Investment Loan Payment (Pg. 4, G)	$4,395		$4,395	
Total Loan Pricipals		$20,280		$20,280
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed–Cost Savings)				$4,116
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	$11,720		$11,720	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$10,976	
Total Depreciation		$11,720		$22,696
CASH BALANCE (Net Income – Principals + Depreciation)	(c)	$6,197	(d)	($4,094)

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$17,151	(a) – (b)
ANNUAL CASH BALANCE DIFFERENCE	$10,290	(c) – (d)

ANNUAL SALES SUMMARY

SPECIES: Hybrid Striped Bass

UNIT: Pounds

HARVEST 1

TOTAL UNITS HARVESTED	145,800	<--Insert
PRICE PER UNIT	$1.00	<--Insert
AMOUNT OF SALE	$145,800	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	3,645	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$3,645	(Total Sales / No. of Acres)

HARVEST 2

TOTAL UNITS HARVESTED	0	<--Insert
PRICE PER UNIT	0.00	<--Insert
AMOUNT OF SALE	$0	(Units Harvested x Price per Unit)
NUMBER OF ACRES	40	<--Insert
UNITS HARVESTED / PER ACRE	0	(Total Units Harvested / No. of Acres)
AMOUNT OF SALE / PER ACRE	$0	(Total Sales / No. of Acres)

TOTAL ANNUAL SALES	$145,800	(Harvests 1 & 2)

Hybrid Striped Bass ANNUAL INCOME STATEMENT

REVENUE	*With USCOE*		*W/out USCOE*	
Total Annual Sales		$145,800		$145,800
EXPENSES				
A. Total Variable Costs (Pg. 3)	$115,431		$115,431	
B. Total Fixed Costs (Pg. 4)	$19,813		$19,813	
Total Expenses with USCOE		$135,244		$135,244
C. USCOE FIXED-COSTS SAVINGS (Pg. 4)			$17,151	
Total Expenses w/out USCOE				$152,394
NET INCOME	(a)	$10,557	(b)	($6,594)

ANNUAL CASH BALANCE STATEMENT

NET INCOME		$10,557		($6,594)
LOAN PRINCIPALS				
Operating Loan Payment (Pg. 3, E)	$15,885		$15,885	
Investment Loan Payment (Pg. 4, G)	$4,395		$4,395	
Total Loan Pricipals		$20,280		$20,280
USCOE'S Investment Loan Payments (Pg. 4, EE) (Aquaculturist's Fixed-Cost Savings)				$4,116
DEPRECIATION				
Aquaculturist's Investment (Pg. 4, C)	$11,720		$11,720	
USCOE Investment (Savings) (Pg. 4, CC)	$0		$10,976	
Total Depreciation		$11,720		$22,696
CASH BALANCE (Net Income – Principals + Depreciation)	(c)	$1,997	(d)	($8,294)

VALUE OF USCOE'S PARTICIPATION

ANNUAL NET INCOME DIFFERENCE	$17,151	(a) – (b)
ANNUAL CASH BALANCE DIFFERENCE	$10,290	(c) – (d)

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
September 1993

3. REPORT TYPE AND DATES COVERED
Final report

4. TITLE AND SUBTITLE
Economics and Marketing of Aquaculture in Dredged Material Containment Areas

5. FUNDING NUMBERS
Contract No.
DACW39-89-C-0020

6. AUTHOR(S)
C-K Associates, Inc.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
C-K Associates, Inc.
17170 Perkins Road
Baton Rouge, LA 70810

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U. S. Army Corps of Engineers, Washington, DC 20314-1000;
U. S. Army Engineer Waterways Experiment Station
Environmental Laboratory, 3909 Halls Ferry Road,
Vicksburg, MS 39180-6199

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
Technical Report
EL-93-19

11. SUPPLEMENTARY NOTES
Available for National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

High land and construction costs hinder development of pond-based aquaculture in the United States. A partnership with the U.S. Army Corps of Engineers (USACE) may reduce these constraints. The dredged material containment areas (DMCA) operated by the USACE are structurally similar to aquaculture ponds and typically are used by the USACE only once every 3 to 10 years. With the Corps and navigational interests contributing to dike construction and land acquisition, the costs of aquaculture may be reduced while providing the Corps with the additional disposal areas needed to maintain our nation's waterways. The Containment Area Aquaculture Program (CAAP) was established to investigate the feasibility of DMCA aquaculture from biological, economic, engineering, and legal perspectives. The technical feasibility of DMCA's was demonstrated in 42- and 47-ha DMCA's near Brownsville, TX. Pumps, filters, and drainage structures were added to these DMCA's to accommodate aquaculture operations and a 1.6-ha nursery pond was constructed. During a 3-year period, four crops of penaeid shrimp were raised. Production rates averaged 670 kg/ha of whole shrimp (range: 338 to 1,143 kg/ha) with 51 percent survival (range: 23 percent to 74 percent). Total production for the four crops was 116,088 kg of whole shrimp (71,878 kg tails), and this was sold for over $475,000.

(Continued)

14. SUBJECT TERMS
Aquaculture
DMCA
Beneficial uses
Economics
CAAP

15. NUMBER OF PAGES
120

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT
UNCLASSIFIED

18. SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

19. SECURITY CLASSIFICATION OF ABSTRACT

20. LIMITATION OF ABSTRACT

13. (Concluded).

This report gives a general overview of the economics and marketing of aquaculture products raised in DMCA's. AQUADEC, a computer program developed under the Florida Sea Grant Program for examining the feasibility of aquaculture enterprises, was used to generate financial statements for the Brownsville demonstration project, including cost recovery schedules, loan amortization schedules, income statements, monthly cash flow statements, balance sheets, and operating budgets. Exact values for these parameters cannot be obtained because of differences between the input requirements of AQUADEC and the records kept by the Corps and contractors running the demonstration farm; however, some general conclusions can be made. The Brownsville shrimp farm showed that aquaculture in a DMCA is feasible, based on both yield and production costs. Compared to a typical aquaculture operation, the major potential incentive to using a DMCA is the reduction in pond construction costs. For the demonstration project, the combined capital savings from having USACE participation was estimated at $271,000, or about $1,200 per acre. In an industry known for scarcity of funds available from financial institutions, this capital savings is valuable. The value of using a DMCA beyond the initial construction costs are difficult to estimate and probably would vary significantly on a project-by-project basis.

Several hypothetical aquaculture enterprises were studied to examine the trade off between reduced construction/operation costs and reduced access to the ponds because of dredging operations. All operations involving catfish, crawfish, hard clams, and hybrid striped bass should benefit from using DMCA's. These simulations were done with a series of six Lotus 1-2-3 spreadsheets that can be easily modified to investigate specific scenarios. The worksheets accept and calculate data for construction costs, initial investment costs, annual variable costs, annual fixed costs, annual sales and summary, annual income statements, and annual cash balance statements.